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Why so much Smut in Spring Wheat?

November 1, 1930

BUREAU OF
PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE

PLANT DISEASE REPORTER

Plant Disease Reporter
Supplement 77

November 1, 1930

WHY SO MUCH SMUT IN SPRING WHEAT?

THE RESULTS OF THE 1930 SURVEY TO COLLECT INFORMATION ON THE PREVALENCE OF STINKING SMUT OR BUNT AND METHODS OF SEED TREATMENT FOLLOWED IN SELECTED SPRING WHEAT COUNTIES

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From data collected by various persons in the above-mentioned institutions as mentioned on pages 98 and 99 of this report.

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INTRODUCTORY STATEMENT

For several years the losses from stinking smut or bunt of wheat in Minnesota, North Dakota, South Dakota, and Montana have been excessive. Previous to 1925 the annual carload receipts of wheat grading smutty at Minneapolis had been considerably less than 1 per cent. Commencing in 1926, however, and continuing in 1927 the receipts of smutty wheat jumped from 1 to more than 11 per cent and for the crop years 1928 and 1929 nearly 15 per cent and 13 per cent respectively graded smutty.

The amount of smut in the present year's crop as shown by wheat receipts in the Minneapolis market cannot definitely be given until after the crop has been received. As an example of what is happening, however, it may be stated that the Minneapolis receipts for July, August, and September, 1930, showed about 21 per cent smut as compared with the receipts in that city for the same months of last year which averaged 13 per cent smutty.

As this rather alarming increase has become evident there has been an extension of research and control activities in the States concerned. Some of them have undertaken additional investigative projects and all of them have devoted greater attention to smut control from the extension standpoint. Business men in Minneapolis became actively interested in smut prevention. Special literature has been prepared and distributed. An increasing number of elevators have adopted the practice of buying wheat on a quality and grade basis and discounting smutty wheat. Demonstration trains emphasizing wheat smut control have been run by certain of the railroads. Community seed cleaning and treating outfits have been operated and extension specialists and county agents generally have given more thought and time to the matter of reducing losses from wheat smut.

These efforts have done much to reduce the loss from this disease. As an instance there may be mentioned the results of the campaign in Brown County, South Dakota, where the farmers, with the aid of the Extension Service and the Northwest Crop Improvement Association and cooperating agencies, put on a rather intensive seed treatment campaign. The following table (Table 54) shows that the total Minneapolis receipts of 1928 wheat from all points in the spring wheat area averaged 15.7 per cent of the crop grading smutty whereas the receipts for Brown County of that year were 41.5 per cent smutty. The campaign was begun in the winter of 1928-29 by the Northwest Crop Improvement Association cooperating with the County Agent of Brown County and the Extension Agronomist of South Dakota with the result that the 1929 crop from Brown County graded only 17 per cent smutty as compared with 12.6 from the entire spring wheat area. Furthermore, the average discount per car was reduced more than one-half during that same period. The 1930 Brown County crop is showing 15.5 per cent smut on the basis of 943 carloads received up to October 28, thus indicating a still further decrease in the face of general increases in the entire spring wheat area.

In general, however, smut still continues as a serious problem in the spring wheat states. Market figures that have been gathered do not show the marked reduction in the amount of smut that would be expected. In fact they show that instead of decreasing the smut is increasing in prevalence in many places.

What is the reason for this continued severity? Are not enough farmers treating their seed? Are those that are treating failing to control, if so why? Are the chemicals that are being used inferior? Are improper methods being followed? Are there other important but less evident factors operating to account for these losses? These are some of the questions raised by Mr. R. H. Sumner, executive secretary of the Northwest Crop Improvement Association, which were considered at a meeting of the Extension and Experiment Station Directors in Chicago, November 11, 1929. They have also been given consideration at other

conferences on smut control in the States. In all cases it was pointed out that not enough information was available to answer these questions satisfactorily. It was therefore decided that as a part of the smut control work for 1930, a survey to obtain more facts be included.

Table 54. Percentage of car loads grading smutty and average discount of wheat from Brown County, South Dakota, as compared with average Minneapolis receipts, crops of 1928 and 1929. (Results of a summary by South Dakota Extension Service, U. S. Office of Grain Investigations and Northwest Crop Improvement Association).

Wheat Receipts	Percentage cars grading smutty		Average discount (cents per bu.)	
	1928	1929	1928	1929
Brown County average	41.5	17.0	5.6	2.2
Average Minneapolis receipts	15.7	12.6	4.0	2.3

COOPERATING AGENCIES AND ACKNOWLEDGMENTS

The general plans for the work herein reported were developed by the State Extension and Experiment Station Directors, the extension specialists in plant pathology and agronomy of the United States Department of Agriculture, the Secretary of the Northwest Crop Improvement Association, and others, at the time of the Land Grant College meeting in Chicago, November 11, 1929. The more detailed arrangements were made later by the State extension and research workers, in conjunction with O. S. Fisher, R. H. Black, H. R. Sumner and the senior author.

In Minnesota the Extension Department and the section of Plant Pathology of the College of Agriculture cooperated in financing and conducting the work. R. C. Rose, Extension Plant Pathologist, assisted by Messrs. Holton and Kauffert, devoted three weeks to the business of interviewing wheat growers and making counts in their fields.

In North Dakota, W. E. Brentzel, Plant Pathologist for the Experiment Station, and E. G. Booth, Extension Agronomist for the College, were the principal cooperators. Mr. Brentzel conducted the field work.

In South Dakota, Extension Agronomist R. E. Johnston was in charge. He made the plans and obtained records through the county agents. The field survey was conducted for the most part by E. A. Walker, Department of Botany and Plant Pathology, South Dakota Agricultural College. Mr. Walker also made the survey in Towner County, North Dakota.

In Montana, Waldo Kidder of the Agricultural College was leader of the survey. He was assisted by F. C. Meier, U. S. Bureau of Plant Industry, who worked a week in Gallatin County, H. E. Morris of the Department of Botany and Bacteriology, A. G. Goth, Assistant Agronomist, and by P. A. Young of the Botany Department.

The Northwest Crop Improvement Association, through its Secretary, H. R. Sumner, has encouraged the survey from the outset. Mr. Sumner took a leading part in initiating and laying plans for the work, and personally assisted with the field inspections.

Messrs. F. C. Meier and O. S. Fisher of the U. S. Department of Agriculture, who have devoted much time and effort to the wheat smut control problems, were of primary assistance. They showed the needs for the survey, helped to lay the foundations for it, and have encouraged and promoted it during its entire progress.

Messrs. E. G. Boerner and R. H. Black, Office of Grain Investigations, and M. A. McCall, A. G. Johnson, R. W. Leukel, and others in the Office of Cereal Crops and Diseases, U. S. Department of Agriculture, have rendered very valuable assistance by encouraging and advising with the work, by reading the manuscript of this report, and in other ways.

The Plant Disease Survey, U. S. Bureau of Plant Industry, arranged for and coordinated the survey; paid salaries and expenses for the field work in South Dakota; Towner County, North Dakota; and several counties in Montana; and assisted in the preparation of this report.

OBJECTS OF THE SURVEY

The objects of the survey as finally decided upon were:

1. To determine more accurately the field losses from stinking smut in the spring wheat area.
2. To determine the percentage of farmers treating wheat seed in selected typical counties.
3. To check on the effectiveness of seed treatment, the methods found in use, and if these are not proving thoroughly satisfactory to try to find out why.
4. To learn which varieties are most affected, the relative amount of smut in durum and hard red spring wheat, the influence of date of planting, and other similar facts.

PLAN OF SURVEY

Since no special funds were available to pay the cost of the field work, it was decided to outline a uniform or standard method of procedure that would be acceptable to the States concerned and that could be followed by those cooperating. With all surveyors using the same methods and forms, results in the various States should be comparable.

In North and South Dakota it was thought advisable to divide the survey into two parts: (1) a seed survey in the spring during or immediately after planting to gather detailed facts concerning methods of seed treatment at the time when they were still fresh in the farmer's mind; and (2) a field survey after the wheat had headed, but before harvest, in order to determine percentages of smut in the fields. It was thought that time could be saved in many cases if the county agents obtained seed treatment data and made these available to the field survey men when they made their inspections during the summer. These preliminary records were obtained and used to some extent, especially in South Dakota. A sufficient number of neighboring untreated fields were surveyed at random in order to give a fairly reliable picture of the actual conditions. In general it is thought that the field surveys can be considered as representative of the areas surveyed.

With the assistance of those most concerned, standard forms for recording data were prepared: (1) a seed treatment form and, (2) a field record form. (See specimens on following pages).

STINKING SMUT OF WHEAT

Seed Treatment Survey

Grower:..... State:.....

Address:..... County:.....

Variety of wheat:..... Date:.....1930

Method of Treatment: Materials used (check which)

Fifty per cent copper carbonate:.....Formaldehyde:.....
Twenty per cent " " :.....Other:.....
Ceresan :.....None:.....

Total amount of treating materials used:.....
Total number of bushels treated:.....
Cost of treating materials used: (Per pound or per pint).....

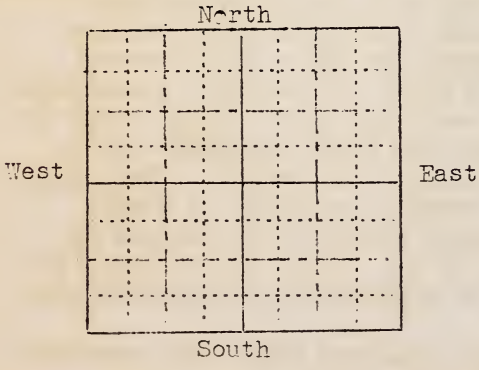
Method of treating seed:.....
(Kinds of machines, methods of mixing, etc.)
.....

Time required treating each "mix":.....
Number of bushels in each "mix":.....
Method of handling after treating:.....
Date seed treated:.....1930 Date seed sown:.....1930
Do you treat wheat every year?..... How often?.....

Method of Sowing Seed:

Crop on land 1929:..... Crop on land 1928.....
Rate of seeding:.....lbs. per acre Drill set at.....lbs. per acre
Was drill injury noted:
Condition of soil at planting time: (check which) Dry...Moist....Wet.....
Acres sown: (a) Treated seed.....(b) Untreated seed.....

Location of Field:



On this diagram mark the exact location of acreage sown with treated seed. Each small square represents 10 acres.

Section.....

Township.....Range.....

.....
(Miles and direction from Post Office)

Remarks:

Recorded by:.....

STINKING SMUT OF WHEAT

Field Survey

Grower:..... State:.....

Address:..... County:.....

Variety of wheat:..... Date:.....1930

Method of Treatment: Materials used (check which)

Fifty per cent copper carbonate:.....Formaldehyde:.....
Twenty per cent " " :.....Other:.....
Ceresan :.....None:.....

Total amount of treating materials used:.....
Total number of bushels treated:.....
Cost of treating materials used: (Per pound or per pint).....

Method of treating seed:.....
(Kinds of machines, methods of mixing, etc.)
.....

Time required treating each "mix":.....
Number of bushels in each "mix":.....
Method of handling after treating:.....
Date seed treated:.....1930 Date seed sown:.....1930
Do you treat wheat every year?..... How often?.....

Method of Sowing Seed:

Crop on land 1929:.....Crop on land 1928:.....
Rate of seeding:.....lbs. per acre Drill set at.....lbs. per acre
Was drill injury noted:.....
Condition of soil at planting time: (check which) Dry....Moist....Wet....
Acres sown: (a) Treated seed..... (b) Untreated seed.....

Smut Infection: Make 10 counts, 1 yard of row for each count.

Count number	Smutted heads
1.....	.....
2.....	.....
3.....	.....
4.....	.....
5.....	.....
6.....	.....
7.....	.....
8.....	.....
9.....	.....
10.....	.....
Totals.....	.....
Average	

Stand (Check which)Good..Fair...Poor...
Yield per acre (treated seed).....
Remarks:

Recorded by.....

SURVEY METHODS

The men engaged in the field survey, on starting work in any particular county, first made contact with the county agent. In the Dakotas several agents had already obtained seed treatment data. Routes were then planned into several different and representative parts of the county. Traveling by automobile either singly or in pairs, the survey men stopped at farms along the route, found the farmer, obtained the necessary information from him and made counts to determine the percentage of smut in the fields.

In determining percentages of smut a yard of drill row was measured with a yard stick carried by the surveyor and the number of diseased and healthy heads counted in the yard row. (See Plate 1. Photographs by F. C. Meier). This was repeated in 10 different parts of the field, the ten sets of counts totaled and averaged.

In some kinds of wheat smut is much easier to detect than in others. The symptoms in durum, especially when the heads are relatively immature, are often very obscure. Aside from an indefinite bluish tinge of the glumes and stunting of the culm and head, there seem to be no reliable external signs. With durum it was often necessary to pinch or cut open the kernel in several different parts of the head before a definite determination could be made. The heads from a yard row of smutty durum are shown in Plate 2 B. Aside from the shorter growth there is little externally to distinguish the diseased from healthy specimens.

For the reasons stated above, it is easy to understand how a farmer may not realize that there is any smut in his wheat until possibly at threshing time when he examines the grain, and even then if the percentage is small he may think that his wheat is free from smut until it is discounted when he hauls it to the elevator. If his wheat is not discounted, as is still the practice with many elevators, he may think that it is entirely clean and that his seed does not need to be treated for next year's crop. The result may be an unusually heavy infestation of smut. The increasing practice of elevators to discount for smut encourages seed treatment, not only because of the effect on the farmer's pocketbook but because it lets him know when his wheat is smutty.

COUNTIES SELECTED FOR SURVEY

A few typical counties were selected in each State for surveying as follows. The locations of these are shown on the accompanying map (Figure 8).

MINNESOTA: Redwood, Wilkin and Polk.
Redwood County was chosen as an example of an important county that, according to Minneapolis receipts, had a large amount of smut. The other two were selected as examples of counties where considerable seed treatment is being done.

NORTH DAKOTA: Cass, Steele, and Towner.

SOUTH DAKOTA: Brown, Day, Marshall, and Spink.

MONTANA: Gallatin, Cascade, Fallon, Judith-Basin, Fergus, Wibaux, and Yellowstone.

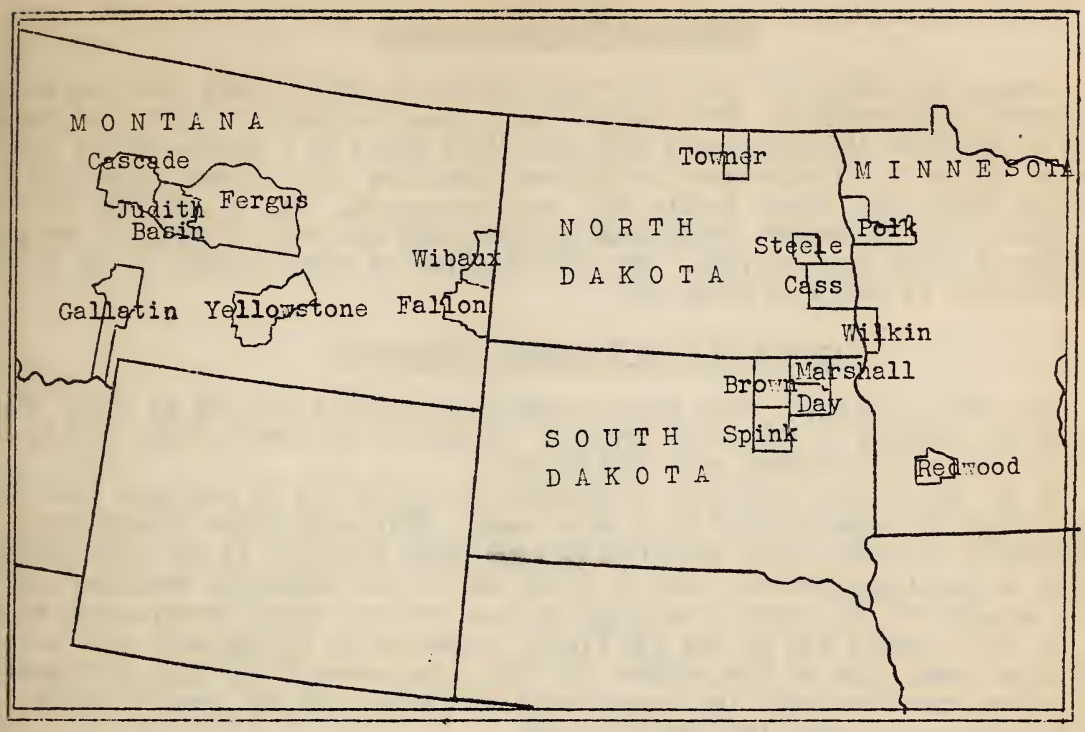


Fig. 8. States and counties where smut surveys were conducted.

TIME REQUIRED

An idea of the amount of work performed, the number of men engaged in the survey and the actual dates of the inspections can be obtained from the following. A rough estimate of the cost of the work, which was borne by several different organizations could also be obtained from these figures if desired.

MINNESOTA: 56 days as follows:

Three men	16 days	each July 10-25	(Redwood, Wilkin, Polk Counties)
One man	4 days	July 16-29	(Wilkin County)
One man	4 days	July 21-24	(Polk County)

NORTH DAKOTA: 20 days as follows:

Two men	6 days	each July 14-19	(Cass and Steele Counties)
One man	8 days	August 7-14	(Towner County)

SOUTH DAKOTA: 36 days as follows:

One man	33 days	each July 1-August 2.	
One man	3 days	July 10-12	(Brown County)

MONTANA: 24 days as follows:

One man	6 days	July 23-29	(Gallatin Co.)
One man	13 days	July 21-29, August 7, 9, 16.	
One man	3 days	July 23-25	
One man	2 days	August 6-7	

RESULTS - SPRING WHEAT

Number of Fields Surveyed

During the course of the survey 704 fields of spring wheat totaling nearly 50,000 acres were examined. For the most part these belonged to different farmers but in numerous instances more than one field owned by a single grower was examined. These were distributed as follows among the four states: Minnesota 298, North Dakota 132, South Dakota 227, and Montana 47. All of the 106 winter wheat fields were in Montana where smut in this crop has been recognized for several years as being very serious. The distribution of these fields in the different counties in shown in table 56.

Amount of Seed Treatment Practiced

The survey has shown that seed treatment is being practiced by about two-thirds of the farmers in the areas covered. Sixty-six per cent of the fields examined were sown with treated seed (Table 55).

Of the 298 fields inspected in Minnesota only 116 or 39 per cent were sown with seed that had been treated to prevent smut. This represents considerably less treatment in these three counties than in those surveyed in the other States. It should be mentioned however that at least one of the Minnesota counties was selected because of the large percentage of cars grading smutty originating there.

In North Dakota 115 of the 132 fields inspected or 87 per cent were sown with treated seed. One of the reasons for this high average was that in Towner County, where more than half the inspections were made, all but one of the 81 fields examined were sown with treated seed.

In South Dakota where 227 fields were surveyed, 171 or 75 per cent were found to have been sown with treated seed. In the four counties selected in this State, particularly in Brown County, there has been considerable activity on the part of county agents and others to interest farmers in treating their seed.

In Montana 32 out of 47 fields of spring wheat, or 68 per cent were sown with treated seed, and practically all (92 per cent) of the winter wheat was treated in one way or another.

Table 55. Percentages of farmers treating wheat seed for smut prevention in areas surveyed in four spring wheat States.

State	Per cent farmers treating
Minnesota	39
North Dakota	87
South Dakota	75
Montana (spring wheat)	68
Montana (winter wheat)	92
Average all spring wheat	62
Average all wheat	66

Amount of Smut Found

The average amount of smut found in the spring wheat fields, 704 in number, was 2.8 per cent. The 434 treated fields showed 2 per cent and the 270 untreated fields just double that amount, 4 per cent (Table 56).

The highest percentage of stinking smut found in any spring wheat field during the course of the survey was 51.7 (52) per cent. This was a 20-acre field of durum, the seed for which had not been treated, near Crookston, Polk County, Minnesota.

The same grower had another 120 acre field of the same wheat. The seed had been treated however by spraying with formaldehyde at the rate of one pint of formaldehyde to 4 gallons of water to 40 bushels of wheat and allowing to remain sacked over night. This field had 5.7 per cent smut.

The second smuttiest field was a 9-acre Minnesota field of Marquis, but in this case the seed was supposed to have been treated with formaldehyde applied by the sprinkling and shoveling method. It showed 48 per cent smut.

The field rating third in percentage of smut was 84 acres of durum wheat from untreated seed. It was located near Rothsay, Wilkin County, Minnesota, and showed 42.7 (43) per cent smut when inspected July 19.

The three highest percentages of smut in treated spring wheat were as follows. All seed lots were supposed to have been sprinkled with formaldehyde. Some of them were known to have been very smutty.

Marquis	Minnesota	48 per cent
Durum	Minnesota	33
Marvel	South Dakota	31

In untreated spring wheat fields the maximums were:

Durum	Minnesota	52 per cent
Durum	Minnesota	43
Marquis	Minnesota	37

In Minnesota the treated fields contained an average of 3.6 per cent, with maximum percentages of 48, 33, and 25, as compared with 4.6 per cent in the untreated, maximums 52, 43, and 33. This is entirely too much smut in the treated fields. Much better control than that should have resulted. As is shown later in this report the cause of this is primarily poor methods of seed treatment and lack of sufficient attention to details.

In North Dakota the treated fields contained an average of 1.2 per cent smut, the three maximum percentages being 17, 12, and 8. The untreated fields showed 4.8 per cent with maximums of 20, 13, and 10. This clearly shows that seed treatment was worth while. A reduction in smut of 3.6 per cent in a 100,000,000 bushel crop represents a saving of some two and one-half million dollars even when wheat is selling as low as 70 cents per bushel. On the other hand, the average of 1.2 per cent smut in the treated fields is too high. It has been demonstrated repeatedly that it is possible, through the use of proper methods, to reduce smut to a trace and, in fact, entirely eliminate it.

In South Dakota treated fields the average per cent smut was 1.5 and the three highest percentages 31, 20, and 16. The untreated fields of that State averaged 2.8 per cent with maximums of 20, 15, and 13.

In Montana the fields of spring wheat from treated seed showed only 0.4 per cent smut and the three highest percentages found were 4, 2, and 2. The untreated fields showed 3.1 per cent with 32, 4, and 2 per cent as maximums. This indicates that smut in Montana spring wheat in the areas surveyed is not as serious a matter as in the States farther east.

Further details on the percentages of smut in treated and untreated seed are given in table 56.

Table 56. Average percentage of smut in treated and untreated fields of spring wheat.

State and County	Number of fields inspected	Number of fields treated seed	Average per cent smut treated seed	Number of fields untreated seed	Average per cent smut untreated seed
MINNESOTA					
Redwood	101	41	4.7	60	6.0
Wilkin	94	43	2.8	51	4.9
Polk	103	32	2.1	71	3.2
State	298	116	3.3	182	4.6
NORTH DAKOTA					
Cass	26	14	1.2	12	4.8
Steele	25	21	3.0	4	5.9
Towner	81	80	0.8	1	0
State	132	115	1.2	17	4.8
SOUTH DAKOTA					
Spink	42	38	2.1	4	0
Brown	60	46	1.3	14	1.7
Day	64	40	1.2	24	3.9
Marshall	61	47	1.5	14	3.1
State	227	171	1.5	56	2.8
MONTANA					
Failon	14	13	.4	1	2.0
Judith Basin	3	1	.8	2	1.4
Cascade	5	4	.6	1	0
Fergus	4	3	.2	1	0
Wibaux	6	5	.8	1	.1
Gallatin	15	6	.5	9	4.5
State	47	32	.4	15	3.1
TOTAL AND AVERAGES ALL STATES	704	434	2.0	270	4.0
Average percentage of smut in all fields both treated and untreated					2.8

Losses

If an average of 2.8 per cent smut can be considered as representative of all four States, and in general we believe it can, and if we regard the percentage of smut in the field as the percentage of reduction in yield, then the loss in yield amounts to about four million dollars.

According to the October 1930 crop estimate the total production of spring wheat and durum in the four States was 178,391,000 bushels. This is 97.2 per cent of what the yield would have been if there had been no smut. The 2.8 per cent smut therefore represents a loss of 5,138,000 bushels. Even at 78 cents per bushel this much wheat would be worth about $4,000,000.

To this loss must be added the discount that the farmers must take for smutty wheat. The indications are that at least one-fifth of this year's spring wheat crop will be discounted about three cents per bushel. If this proves so the total discount will be slightly over $1,000,000, which, added to the loss in yield, brings a total loss of $5,000,000 to spring wheat growers.

Popularity of Different Chemicals for Seed Treatment

Formaldehyde was by far the most common seed disinfectant used, three-fourths of the spring wheat seed treatments recorded being with that chemical. In North Dakota it was employed in 92 per cent of the cases. Montana was the only State where it occupied a position of secondary importance.

Copper carbonate was used in 20 per cent of the cases, the 20 per cent grade in four-fifths of these and the 50 per cent in one-fifth. It was most popular in Montana where it was used in more than half of the treatments. It also apparently has quite a foot-hold in the Minnesota counties studied where it was employed to the extent of 32 per cent.

Ceresan was used in 6 per cent of the cases, being most popular in some of the South Dakota and Montana counties.

Blue vitriol was only used in one case on spring wheat in Montana. With winter wheat, however, it was used in 10 cases.

Two cases of the treatment with hot water were observed in Polk County which had been carried on by a seed grower to control loose smut particularly.

Three instances were recorded of treatment with bluestone and formaldehyde. The growers evidently proceeded on the assumption that if one chemical is good two are better.

Table 57 gives the details on popularity of the different treatments.

Table 57. Number of spring wheat fields sown with treated seed and percentages of those fields treated with various chemicals.

State	Formaldehyde		Copper carbonate 20%		Ceresan		Copper carbonate 50%		Other	
	No. fields:	Per cent:	No. fields:	Per cent:	No. fields:	Per cent:	No. fields:	Per cent:	No. fields:	Per cent
Minnesota	73	65	32	28	5	4	1	1	2*	2
North Dakota	106	92	3	3	2	2	4	3	0	0
South Dakota	125	75	23	14	14	8	4	3	0	0
Montana	11	35	9	28	3	9	8	25	1**	3
All States	315	74	67	16	24	6	17	4	2*	t
									1**	t

* Hot water
** Blue vitriol

Methods of Applying Disinfectants

The number of spring wheat fields treated by different methods are recorded in table 58.

Formaldehyde was applied by the majority of growers by the sprinkling and shoveling method (1 pint of formaldehyde with 40 gallons of water to 50 bushels of seed). In fact nearly one-half of the farmers (196) who did any disinfecting at all, with any chemical, followed this method. In South Dakota it was by far the most common method of treatment, 94 out of 166 growers using it.

The next most popular method was the application of formaldehyde by means of machines. These machines were of several different types, some homemade and some commercial as illustrated in Plates 4 and 5. In general they fall into three classes:

1. The elevator type (Plate 4, A, B, and G) and (Plate 5, C) which elevates the seed out of the solution by an endless chain with paddles. These machines are usually provided with skimmers which skim off the smut-balls, light grains, and weed seeds that float to the surface of the solution. This is a very desirable feature as it is essential to remove the smut-balls if perfect control is desired. In this connection it might be stated that better control would probably have been obtained in some cases if these skimmers had not been removed from the machines as was noticed.

2. The auger type (Plates 4, C and E and 5, G). With these machines the wheat is emptied into the large hopper. The bottom layers are wet in the solution contained in a receptacle below and then elevated out by an auger or screw-like arrangement operated either by hand or by power. Some 15 or 20 of these were found during the course of the survey. The chief objection to these machines is that there is no chance for the smut-balls, wild oats, etc., to rise to the surface of the solution and be removed. They are imprisoned at the bottom of the pile and elevated out with the treated seed.

3. The automatic sprinkle type (Plates 4, H and 5, B and E). This is a very popular type, probably because of its simplicity and low cost, as well as ease and rapidity of operation. About half of all the formaldehyde machines recorded in the survey were of this type. They were particularly popular in Towner County, North Dakota, where many of them are in use. The seed is shoveled into the hopper and runs slowly out at the bottom where it strikes the blades of a propeller-like part setting it in rotation. The formaldehyde solution, in another receptacle, is allowed to escape by gravity through a rubber tube and stop-cock and also impinges on the rotating disc. The whirling seed is thoroughly wet with the solution and falls into a receptacle or onto the floor below. It will be noted that this is essentially a sprinkling treatment. It is not a soaking treatment. There is no chance for smut-balls to be removed.

Other methods of formaldehyde application were dipping in tubs or barrels - 20 cases (Plate 4, F and D) and spraying - 6 cases. Various modifications were reported. A few growers sprinkled or sprayed the grain as it fell into the wagon box from the elevator (Plate 5, D). One grower put one spoonful of formaldehyde on grain in the sacks and stood them on end over night. One farmer who had come to the conclusion that seed treatment was "no good" and that he had just as much smut when he treated as when he did not treat, was found to have applied the concentrated formaldehyde directly from the bottle to the top of the wagon load.

Copper carbonate. Of the total number of 67 who used 20 per cent copper carbonate on spring wheat, 33 applied it with a churn or home-made mixer (Plates 3, B and 5, A and F), 24 tried to apply it by dusting and shoveling the seed and only 9 used commercial machines. One man sprinkled it on the grain in the drill box and expected to get control that way. On Plates 3 and 5 various kinds of commercial and homemade dusting machines found in actual use on the farms are depicted. Some of the churns and home mixers were not provided with baffle-boards which are important to insure thorough mixing but in general most of them looked as if they would do the work if rotated a sufficient number of times (40 rotations at moderate speed). One type of machine was found that mixes the dust with the seed as they fall downward together through a series of diagonally placed baffle-boards (see Plate 3, D). How thorough a job this does cannot be stated by the writers as they have not had experience with it.

The 50 per cent copper carbonate that was being used on spring wheat in 17 cases was applied by machines in 11 cases and by shoveling in 6 cases.

Table 58. Numbers of spring wheat fields sown with seed treated by various methods.

State	Formaldehyde: Commercial machines	Formaldehyde: Sprinkle	Formaldehyde: Dip	Formaldehyde: Spray	20% Copper carbonate: Commercial machines	20% Copper carbonate: Churn or home mixer	20% Copper carbonate: Shovel	20% Copper carbonate: Mix in drill box	Ceresan: Churn mixer or machine	Ceresan: Shovel	50% Copper carbonate: Churn, mixer or machine	50% Copper carbonate: Shovel	Other: Hot water	Other: Blue vitriol	Totals: Total no. treated	Totals: Total no. untreated	Totals: Total
Minnesota	10	57	3	3	6	15	10	1	4	1	1	0	2	0	113	181	294
North Dakota	67	36	0	3	0	3	0	0	2	0	0	4	0	0	115	17	132
South Dakota	16	94	15	0	1	9	13	0	8	6	2	2	0	0	166	57	223
Montana	0	9	2	0	2	6	1	0	3	0	8		0	1	32	15	47
Total four States	93	196	20	6	9	33	24	1	17	7	11	6	2	1	426	270	696

Ceresan was used in 24 cases, 17 by machines similar to those just described and 7 by hand shoveling.

It is surprising to note not only in the application of the liquid formaldehyde treatment but also in the case of these dust treatments how many farmers try to get results by the sprinkle and shovel method. Practically one-third of them applied the dusts in this way in spite of the warnings that have been broadcast to the contrary. It has been pointed out as an ineffective and at the same time unsafe method from the standpoint of the health of the operators.

The hot water treatments were made with a machine primarily designed for treating seed potatoes with hot formaldehyde. The bluestone treatments were made by dissolving copper sulphate in water until it was "good and blue", then dipping sacks containing one bushel of seed into the solution, allowing them to remain until wet through, draining a few hours and then seeding.

Relative Effectiveness of the Different Methods

The effectiveness of the chemicals and methods, by States, is indicated in table 59. There follows a graphic presentation of the average percentages of smut with the different methods arranged in order of apparent effectiveness.

Aside from hot water and blue vitriol, only three fields of which were observed, the most effective methods were the copper carbonates, either the 50 or the 20 per cent grades, and the formaldehyde, applied with machines. All of these reduced smut to less than 1 per cent. The next most effective was the copper carbonate applied with home-made machines. The third best in smut control seemed to be Ceresan. None of the other treatments can be considered as in any way satisfactory, as they all averaged 2 per cent smut or more.

Does it Pay to Treat Wheat Every Year?

One of the questions asked farmers, the answers to which were recorded in most cases especially in Minnesota and the Dakotas, was "Do you treat wheat every year?" The questionnaires of the farmers who treated their seed this year were therefore gone over with reference to this question and the percentages of smut recorded under the two headings "yes" and "no". Farmers who did not treat this year were not included. The results which are summarized in table 60 show that it does pay in the long run. It does not pay to take a chance. Farmers that

Table 59. Average percentages of stinking smut found in fields of spring wheat the seed for which had been treated by various methods.

State	Formaldehyde				20% Copper carbonate				50% Copper carbonate: Ceresan				Other		No treatment
	Commercial machines	Sprinkle	Dip	Spray	Commercial machines	Churn or home mixer	Shovel	Mix in drill box	Churn, mixer or machine	Shovel	Churn, mixer or machine	Shovel	Hot water	Blue vitriol	
Minnesota	0.7	3.9	3.5	8.5	6.3	1.5	7.4	8.2	0.9	0.3	0	-	0	-	4.6
North Dakota	0.6	2.5	-	0.2	-	0.1	-	-	1.9	-	-	1.3	-	-	4.8
South Dakota	2.3	1.0	2.4	-	1.5	0.6	2.7	-	1.5	1.2	0	10.2	-	-	2.8
Montana	-	0.2	0.2	-	0	0.9	0	-	0.7	-	0.4	-	-	0	3.1
Average four States	0.9	2.1	2.0	4.4	0.5	1.1	4.6	8.2	1.3	1.3	0.3	3.2	0	0	4.2

*One field averaged 36.7 per cent, without this the average was 0.5, with it the average was 4.6 per cent.

made it a practice to treat every other year had only one-third as much smut as those who only treat every other year, or only when it is thought necessary. The average farmer does not know when it is necessary to treat. He does not see small amounts of smut, either in his field or seed, and even experts have difficulty in detecting traces. Furthermore, he cannot predict weather favorable for smut. Under favorable weather conditions it sometimes happens that the crop will be very smutty even when the seed carried a very small initial spore load. Again, with every year's treatment the farmer improves his methods and is likely to be better equipped. Taking all things into consideration it would seem best to play safe and treat every year.

Table 60. Effect of annual and systematic treatment on the percentage of smut.

A summary of replies of farmers, who treated their seed this year, to the question, "Do you treat your seed every year?"

State	Seed treated every year		Seed not treated every year	
	Number fields	Per cent smut	Number fields	Per cent smut
Minnesota	66	1.9	35	7.3
North Dakota	105	1.0	9	2.8
South Dakota	125	1.4	39	2.8
Total and average	296	1.4	83	4.7

Figure 9. Effectiveness of different methods of spring wheat seed treatment.

Treatment	No. fields	Average Per Cent Smut
Hot water	2	0
Blue vitriol	1	0
50% Copper Carbonate, machine	11	0.3
20% Copper Carbonate, machine	9	0.5
Formaldehyde, machine	93	0.9
20% Copper Carbonate, home mixer	33	1.1
Ceresan, machine	17	1.3
Ceresan, shovel	7	1.3
Formaldehyde, dip	20	2.0
Formaldehyde, sprinkle	196	2.1
50% Copper Carbonate, shovel	6	3.2
Formaldehyde, spray	6	4.4
20% Copper Carbonate, shovel	24	4.6
20% Copper Carbonate, Mix in drill	1	8.2
No treatment	270	4.2
Total	696	

Varietal Differences

Records of 694 fields, aggregating 47,764 acres, are available for classifying by varieties. This has been done in tables 61 and 62 and Figure 10. Of the 694 fields, 287 or 41 per cent were durum wheats of various kinds in Minnesota and the Dakotas, 233 or 34 per cent were Marquis wheat, and the remainder were other spring wheats of which Ceres, Marquillo, Marvel and Ruby were the most popular in the order named.

The summaries of the Minneapolis wheat receipts for the past three years have shown considerably more smut in durum than in hard red spring wheat. The field data gathered this summer (Tables 62 and 63) show about twice as much smut in untreated durum as in untreated spring wheat. In the treated durum however the percentage of smut was about the same or slightly less than in the treated spring wheat. It was noted that in the counties surveyed a larger proportion of farmers were treating durum than hard red spring. About half the spring wheat fields were sown with treated seed whereas three-fourths of the durum wheat fields were treated. It is possible that durum growers have been spurred to action by the recent high percentages in untreated fields. The average amounts of smut in all durum and all spring wheat fields examined were about the same, 2.7 and 2.9 per cent respectively.

It is probable that not much information concerning the relative susceptibility of the different wheats can be gained from this survey (Table 62 and Figure 10) as in most cases the fields examined were too few in number. All the leading varieties however with the exception of Marquillo seemed to be quite susceptible. Of the 22 fields of Marquillo examined, all of which were in Minnesota, only a very slight trace (0.1 per cent) was found in one field. It is probable that this may be accounted for by the fact that it is a new wheat first distributed by the Minnesota Experiment Station for commercial growing in 1929, and has not yet had the opportunity to become contaminated.

The variety Marvel, fourteen fields of which were inspected in South Dakota, was regularly smutty. One field of supposedly treated seed showed 31 per cent and another 16 per cent. The average was 6.3 per cent.

Marquis is rated as resistant to stinking smut, but that it is only partially so is indicated by the fact that 4.2 per cent was found in untreated fields and 3.6 per cent in all of the 233 fields examined.

Ceres was badly smutted. In 21 untreated fields it showed an average of 8.7 per cent and in the total of 83 fields it averaged 1.7 per cent.

Fourteen fields of Ruby, all but one of which was in Minnesota and all but one of which had been treated, also showed an average of 1.7 per cent smut.

Hope wheat is supposed to resist stinking smut and the survey indicates that it does although percentages of 2, 1.8, 1.0, and 0.3 were observed in four of the 9 fields examined. The average in the 9 fields was 0.2 per cent, in the 3 untreated fields 0.1 per cent.

Table 61. Number of fields, acreage and percentage of smut in different varieties of treated and untreated wheat by States.

Variety and State	Treated			Untreated			Total		
	Number fields	Acres	Per cent	Number fields	Acres	Per cent	Number fields	Acres	Per cent
MARQUIS									
Minnesota	49	1,776	4.6	119	6,260	4.5	168	8,036	4.5
North Dakota	10	713	.1	4	428	1.0	14	1,141	0.1
South Dakota	13	1,237	0.6	3	255	0.6	16	1,492	0.6
Montana	22	5,025	.4	13	1,535	3.9	35	6,560	1.7
TOTAL	94	8,751	2.7	139	8,478	4.2	233	17,229	3.6
CERES									
Minnesota	18	1,046	0.7	11	844	5.8	29	1,890	2.7
North Dakota	20	1,690	.3	6	505	2.1	26	2,195	.7
South Dakota	20	1,268	2.0	4	183	.8	24	1,451	1.8
Montana	4	262	0.5	0	0	0	4	262	0.5
TOTAL	62	4,266	1.0	21	1,532	8.7	83	5,798	1.7
DURUM									
Minnesota	31	1,665	4.2	15	854	16.2	46	2,519	8.1
North Dakota	72	6,934	1.7	9	465	7.2	81	7,399	2.3
South Dakota	115	8,559	1.1	45	2,874	3.4	160	11,433	1.8
Montana	0	0	0	0	0	0	0	0	0
TOTAL	218	17,158	1.8	69	4,193	6.6	287	21,351	2.9

Table 61 (con.) Number of fields, acreage and percentage of smut in different varieties of treated and untreated wheat by States.

Variety and State	Treated			Untreated			Total		
	Number fields	Acres	Per cent	Number fields	Acres	Per cent	Number fields	Acres	Per cent
SUPREME									
North Dakota	4	170	0	0	0	0	4	170	0
Montana	3	240	0	1	10	0	4	250	0
TOTAL	7	410	0	1	10	0	8	420	0
HOPE									
Minnesota	2	14	0	1	10	0	3	24	0
North Dakota	0	0	0	1	25	0	1	25	0
South Dakota	4	76	.5	1	10	.3	5	86	.4
TOTAL	6	90	.3	3	45	.1	9	135	.2
RUBY									
Minnesota	2	53	.2	11	405	2.2	13	458	1.8
South Dakota	1	70	0.5	0	0	0	1	70	0.5
TOTAL	3	123	.3	11	405	2.2	14	528	1.7
MONTANA KING									
Minnesota	1	120	0	1	60	0	2	180	0
South Dakota	1	50	0	0	0	0	1	50	0
TOTAL	2	170	0	1	60	0	3	230	0

Table 61 (con.) Number of fields, acreage and percentage of smut in different varieties of treated and untreated wheat by States.

Variety and State	Treated			Untreated			Total		
	Number fields	Acres	Per cent	Number fields	Acres	Per cent	Number fields	Acres	Per cent
PROGRESS									
North Dakota	3	410	.4	0	0	0	3	410	.4
CANADA HARD									
North Dakota	1	50	0	0	0	0	1	50	0
BLUESTEM									
North Dakota	1	27	6.8	0	0	0	1	27	6.8
MARVEL									
South Dakota	13	1,132	6.6	1	10	2.3	14	1,142	6.3
RENFREW									
South Dakota	1	75	0	0	0	0	1	75	0
KOTA									
South Dakota	1	50	0	0	0	0	1	50	0
BURBANK									
Minnesota	0	0	0	2	10	0	2	10	0
QUALITY									
Minnesota	0	0	0	4	52	.2	4	52	.2

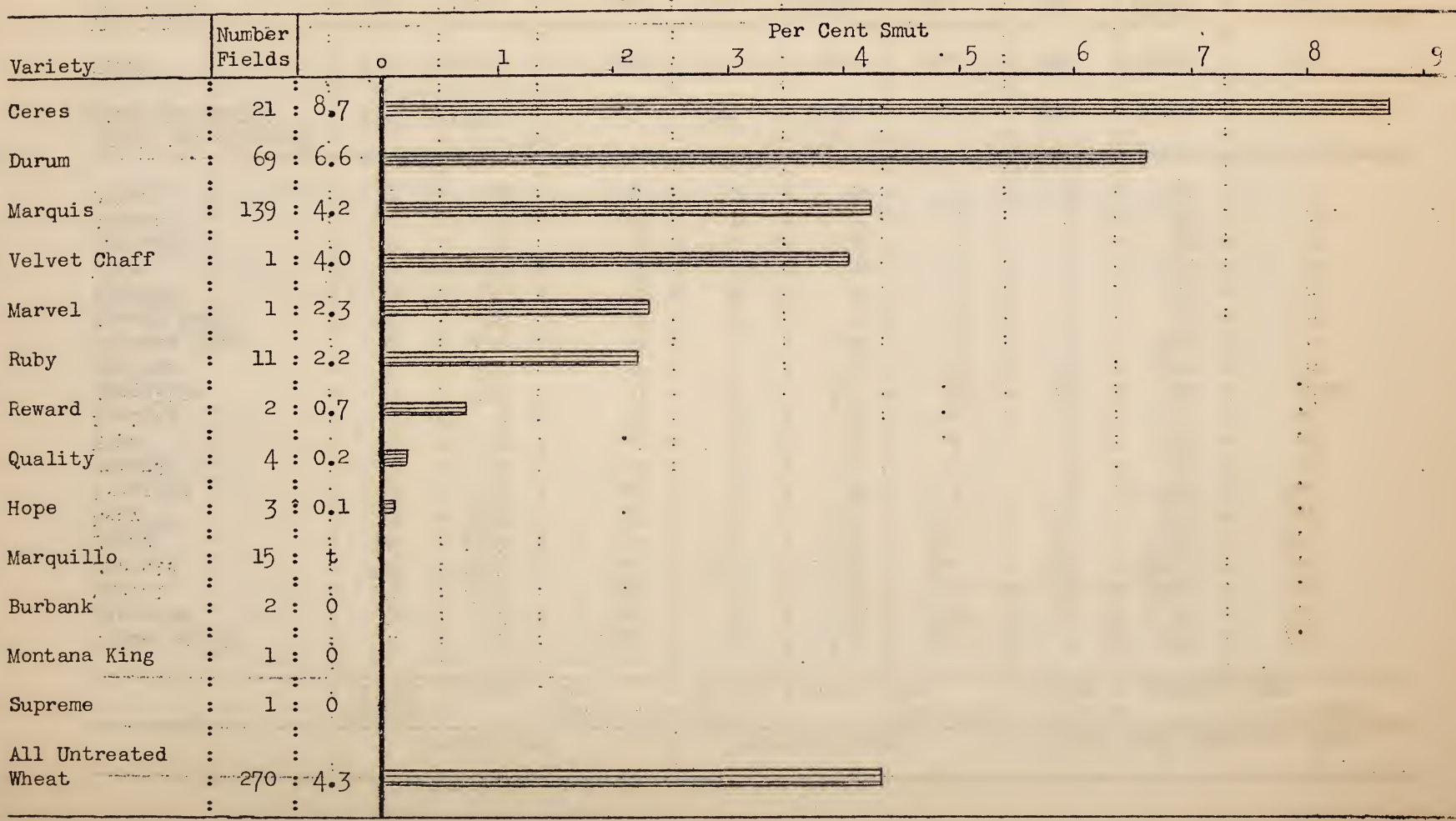
Table 61 (con.) Number of fields, acreages and percentage of smut in different varieties of treated and untreated wheat by States.

Variety and State	Treated			Untreated			Total		
	Number fields	Acres	Per cent	Number fields	Acres	Per cent	Number fields	Acres	Per cent
MARQUILLO									
Minnesota	7	324	0	15	616	.01	22	940	.004
REWARD									
Minnesota	2	36	0	2	54	.7	4	90	.4
GARNET									
Minnesota	1	60	0	0	0	0	1	60	0
VELVET CHAFF									
Minnesota	1	7	11.2	1	120	4.0	2	127	7.6
OTHER									
Minnesota	1	40	0	0	0	0	1	40	0
TOTAL AND AVERAGES ALL WHEAT	424	33,179	1.9	270	15,585	4.3	694	48,764	2.8

Table 62. Number of fields, acreage, and percentage of smut in varieties of spring wheat found in the survey.

	Treated Seed			Untreated Seed			Treated and Untreated Seed		
	Number Fields	Acres	Percentage Smut	Number Fields	Acres	Percentage Smut	Number Fields	Acres	Percentage Smut
Velvet Chaff	1	7	11.2	1	120	4.0	2	127	7.6
Bluestem	1	27	6.8	0	0	0	1	27	6.8
Marvel	13	1132	6.6	1	10	2.3	14	1142	6.3
Marquis	94	8751	2.7	139	8478	4.2	233	17229	3.6
Ceres	62	4266	1.0	21	1532	8.7	83	5798	1.7
Ruby	3	123	.3	11	405	2.2	14	528	1.7
Progress	3	410	.4	0	0	0	3	410	0.4
Reward	2	36	0	2	54	.7	4	90	.4
Hope	6	90	.3	3	45	.1	9	135	.2
Quality	0	0	0	4	52	.2	4	52	.2
Marquillo	7	324	0	15	616	.01	22	940	.004
Supreme	7	410	0	1	10	0	8	420	0
Montana King	2	170	0	1	60	0	3	230	0
Canada Hard	1	50	0	0	0	0	1	50	0
Renfrew	1	75	0	0	0	0	1	75	0
Kota	1	50	0	0	0	0	1	50	0
Burbank	0	0	0	2	10	0	2	10	0
Garnet	1	60	0	0	0	0	1	60	0
Other	1	40	0	0	0	0	1	40	0
TOTAL AND AVERAGES									
HARD RED SPRING	206	16021	2.1	201	11392	3.5	407	27413	2.7
DURUM	218	17158	1.8	69	4193	6.6	287	21351	2.9
ALL WHEAT	424	33179	1.9	270	15585	4.3	694	48764	2.8

Figure 10. Percentage smut in untreated fields by varieties



Variety	Number Fields	
Ceres	21	8.7
Durum	69	6.6
Marquis	139	4.2
Velvet Chaff	1	4.0
Marvel	1	2.3
Ruby	11	2.2
Reward	2	0.7
Quality	4	0.2
Hope	3	0.1
Marquillo	15	t
Burbank	2	0
Montana King	1	0
Supreme	1	0
All Untreated Wheat	270	4.3

Table 63. Relative amount of smut in treated and untreated hard red spring wheat and durum.

KIND OF WHEAT	TREATED		UNTREATED		TOTAL	
	Number Fields	Per Cent Smut	Number Fields	Per Cent Smut	Number Fields	Per Cent Smut
Hard Red Spring	206	2.1	201	3.5	407	2.7
Durum	218	1.8	69	6.6	287	2.9
TOTAL AND AVERAGES	421	1.9	270	4.3	694	2.8

Amount of Control Being Obtained

In order to have an understanding of just what the situation is with regard to control in any particular area, and also to have a definite goal of complete control towards which to direct our extension activities, it is desirable to have a method of expression, or an index or "yard-stick" of control. We might use the average percentage of smut in a given area as the index. This is the one commonly employed. A method that would give a more exact knowledge of what is actually accomplished, however, might be the following:

> Smut control depends on two factors, (1) The percentage of farmers treating their seed, and, (2) the degree or percentage of success being obtained by the farmers who treat their seed. Why not select an index of control based on these two factors? In other words, multiply one by the other.
>
> Percentage of Farmers Treating. These percentages as determined for the areas covered by the present survey are given in Table 55, on page 104.
>
> Percentage of Success. The degree, or percentage, of success may be considered as the percentage by which smut is reduced by seed treatment. For instance, the North Dakota farmers succeeded in reducing smut from 4.8 per cent in the untreated fields to 1.2 per cent in the treated. This reduction of 3.6 per cent is 71 per cent of the total reduction possible. It falls short of complete success by 29 per cent. Seventy-one per cent is therefore the percentage of success. For the other States these percentages are shown in Table 64.

Table 64. Relative success of control methods being used in the four States.

State	Percentage of smut		Difference between treated and untreated	Percentage of Success
	Treated	Untreated		
Minnesota	3.6	4.6	1.0	21
North Dakota	1.2	4.8	3.6	71
South Dakota	1.5	2.9	1.4	48
Montana (Spring wheat)	0.4	3.1	2.7	87
Montana (Winter wheat)	5.7	24.8	19.1	77
All Spring Wheat	2.0	4.0	2.0	50

Index of control. This can now be obtained by multiplying the two foregoing percentages.

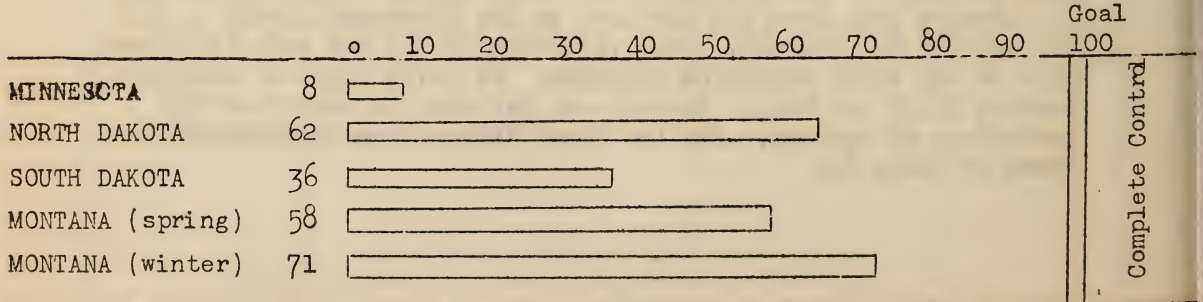
Index of control = Percentage of farmers treating x percentage of success attained by farmers treating.

To illustrate - In South Dakota 75 per cent of the farmers in the areas surveyed treated their seed. This 75 per cent was successful in reducing smut on the average from 2.8 to 1.5 per cent, a reduction of 48 per cent. Index of control= 0.75 x 0.48 = 0.36

If, therefore, we multiply the percentages in Table 55 and Table 64, indexes of control for the areas surveyed are obtained. These are represented graphically in Fig. 11.

By the use of successful methods and by encouraging more farmers to treat, these indexes can gradually be pushed toward the goal of complete control, i. e., 100 per cent.

Figure 11. Percentage of control actually obtained in areas surveyed.



RESULTS - MONTANA WINTER WHEAT

A total of 110 fields of winter wheat, all in Montana, were inspected during the survey. No winter wheat fields were observed in the other States. In the seven Montana counties surveyed, however, winter wheat fields out-numbered spring wheat fields in the proportion of 7 to 3.

Seed treatment of winter wheat was found to be very general. Of the 110 fields all but 9 had been planted with treated seed. The probable reason for this is the very smutty condition of winter wheat. Smut is a much more serious problem in winter than in spring wheat in Montana.

Amount of Smut Found

The treated fields showed an average of 5.9 per cent smut and the untreated 24.8 per cent. The average amount of smut in all fields both treated and untreated was 7.4 per cent.

The highest percentage of stinking smut found in Montana winter wheat, and in fact in any field during the entire survey, was 54 per cent in a fifty-acre field of Turkey in Gallatin County. The seed for this field was said to have been treated with 20 per cent copper carbonate applied with an old type, commercial, dusting machine. Just what was the reason for failure could not be ascertained but the screenings indicated that very smutty seed had been used. It was planted on summer fallowed land, following wheat.

The second highest amount of smut was also in Turkey wheat in Gallatin County. The seed had not been treated but was said to have been well cleaned, and planted on summer fallow, following wheat. The 350 acres showed an average of 50.7 (51) per cent smut.

The field rating third in smut percentage was 100 acres of Kharkof near Moccasin, Judith Basin County. The seed had not been treated and was sown on land that had been in wheat in 1929. It showed 39 per cent smut. Some of the same seed had been sold to a neighbor who treated it and reported no smut in his crop. Since his grain had been cut no counts to verify this were made.

Summarizing the maximum percentages of smut in Montana winter wheat we find the following:

Treated seed -		
Turkey	Gallatin County	54 per cent
Turkey	Fallon County	27 per cent
Turkey	Gallatin County	25 per cent
Untreated seed -		
Turkey	Gallatin County	51 per cent
Kharkoff	Judith Basin County	39 per cent
Turkey	Fergus County	33 per cent

Table 65 shows the number of fields and percentages of smut in treated and untreated fields, by counties.

Table 65. Average percentage of smut in treated and untreated winter wheat fields in Montana

County	Number of Fields Inspected	Number of Fields Treated Seed	Average Per Cent Smut in Treated Flds	Number of Fields Untreated Seed	Average Per Cent Smut in Untreated Fields
Gallatin	38	33	8.2	5	22.6
Cascade	9	9	1.8		
Fallon	20	20	7.6		
Judith Basin	14	12	1.6	2	23.3
Fergus	19	17	6.3	2	31.6
Wibaux	1	1	8.5		
Yellowstone	9	9	2.3		
State	110	101	5.9	9	24.8

Average percentage of smut in all fields both treated and untreated - 7.4

Effectiveness of Seed Treatment Methods Used

Copper carbonate, especially the 50 per cent grade, was the most generally used seed disinfectant, over half of the farmers treating with it. (See Table 66) Formaldehyde was applied, principally by the sprinkling and shoveling method, by about one-fourth of the farmers. More cases of treatment with blue vitriol were observed in Montana than in any other State.

Table 67 and Fig. 12 show the relative effectiveness of the different methods employed. With many of the treatments the fields were not numerous enough to give a dependable rating. In general, however, the results agree rather closely with what might be expected and with similar figures on spring wheat, namely that,

1. The formaldehyde sprinkle and shovel method, and also the formaldehyde dip method, whereby a sack containing about a bushel of seed is dipped in a barrel or tub for a few minutes, are decidedly unsatisfactory for stinking smut control. They do not remove smut-balls.
2. The blue vitriol methods did not control for similar reasons.
3. Formaldehyde applied with good commercial machines is the best liquid treatment.
4. Dust treatments can not be made successfully by the sprinkle and shovel method.
5. The dust treatments gave the best control of any of the treatments when applied with good commercial machines or home mixers.

The results also indicate that even with the best practical treatment much difficulty is experienced in reducing smut to a minimum under Montana conditions, and that other factors such as soil infestation may be at work.

Table 66. Number of fields of Montana winter wheat sown with seed treated by different methods.

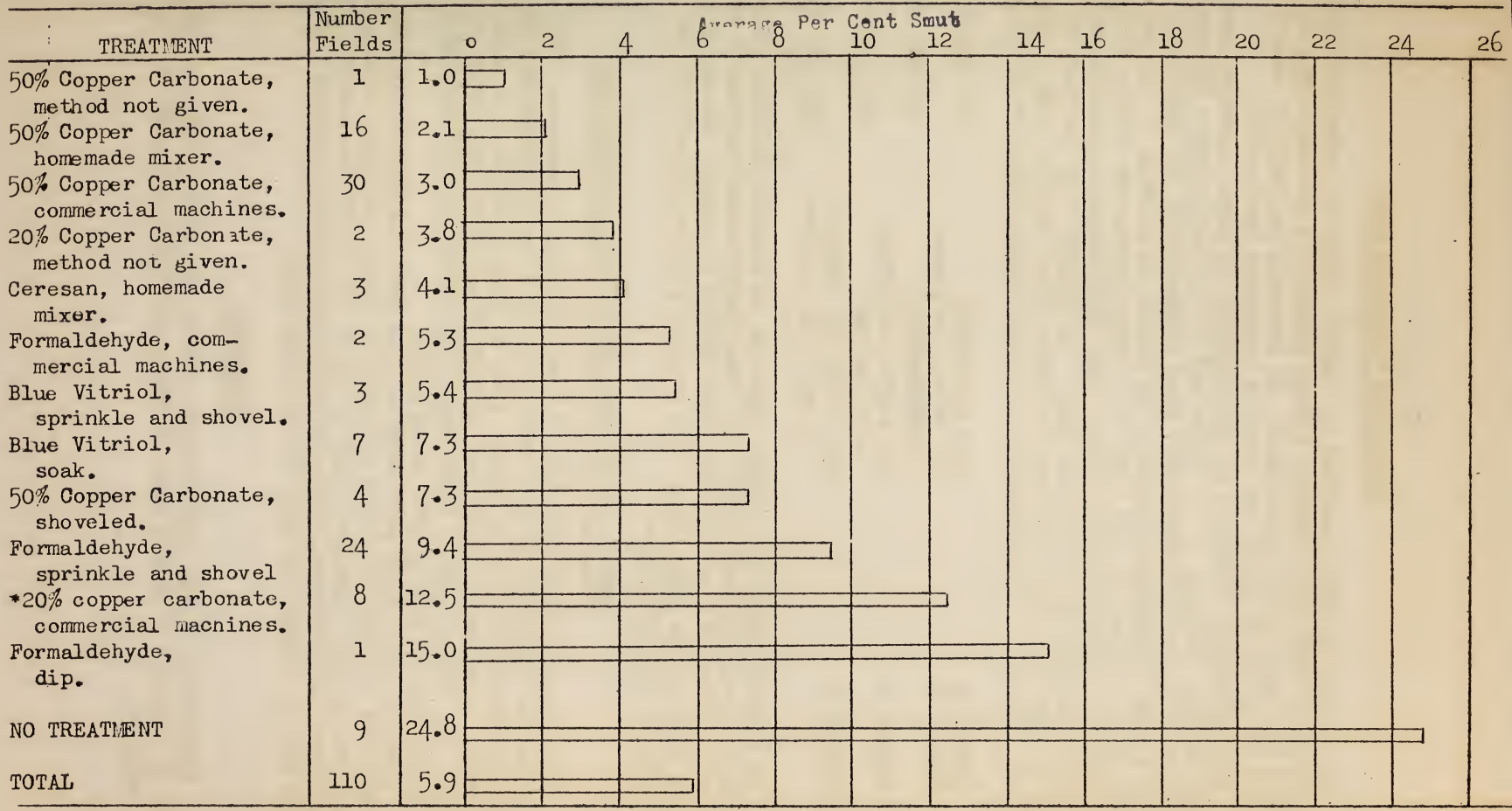
County	Formaldehyde			20% Copper Carbonate		50% Copper Carbonate				Ceresan	Blue Vitriol		TOTALS		
	Commercial machines	Sprinkle	Dip	Commercial machines	Method not given	Commercial machine	Homemade mixer	Shovel	Method not given	Homemade mixer	Soak	Sprinkle	Total treated	Total untreated	TOTAL
Gallatin	0	5	0	3	2	14	1	0	1	0	5	2	33	5	38
Cascade	0	1	0	0	0	3	4	1	0	0	0	0	9	0	9
Fallon	1	11	0	0	0	3	5	0	0	0	0	0	20	0	20
Judith Basin	0	2	0	1	0	4	1	1	0	2	0	1	12	2	14
Fergus	1	0	1	4	0	4	4	2	0	0	1	0	17	2	19
Wibaux	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1
Yellowstone	0	5	0	0	0	2	1	0	0	0	1	0	9	0	9
TOTAL	2	24	1	8	2	30	16	4	1	3	7	3	101	9	110

Table 67. Average percentages of smut found in fields of Montana winter wheat the seed for which had been treated by different methods.

County	Formaldehyde			20% Copper Carbonate		50% Copper Carbonate			Ceresan	Blue Vitriol		Average all treated fields	Not treated	Average all fields
	Commercial machines	Sprinkle	Dip	Commercial machines	Method not given	Commercial machine	Homemade mixer	Shovel	Method not given	Homemade mixer	Soak	Sprinkle			
Gallatin	–	16.4	–	*21.2	3.8	5.0	2.5	+	1.0	–	6.0	6.4	8.2	22.6	10.1
Cascade	–	6.7	–	–	–	1.4	0.6	2.9	–	–	–	–	1.8	–	1.8
Fallon	8.0	10.5	–	–	–	1.6	4.6	+	–	–	–	–	7.6	–	7.6
Judith Basin	–	3.8	–	1.4	–	0.8	0.2	0.1	–	2	–	3.5	1.6	23.3	4.8
Fergus	2.5	–	15.0	8.7	–	1.4	1.5	13.1	–	–	16.6	–	6.3	31.6	8.9
Wibaux	–	–	–	–	–	+	+	+	–	8.5	–	–	8.5	–	8.5
Yellowstone	–	2.7	–	–	–	0.7	1.1	–	–	–	4.8	–	2.3	–	2.3
Average Seven Counties	5.3	9.4	15.0	*12.5	3.8	3.0	2.1	7.3	1.0	4.1	7.3	5.4	5.9	24.8	7.4

*The field showing 54 per cent mentioned on page 121 accounts for this high average.

Figure 12. Relative effectiveness of different methods of seed treatment in 110 fields of Montana winter wheat



TREATMENT	Number Fields	Average Per Cent Smut
50% Copper Carbonate, method not given.	1	1.0
50% Copper Carbonate, homemade mixer.	16	2.1
50% Copper Carbonate, commercial machines.	30	3.0
20% Copper Carbonate, method not given.	2	3.8
Ceresan, homemade mixer.	3	4.1
Formaldehyde, commercial machines.	2	5.3
Blue Vitriol, sprinkle and shovel.	3	5.4
Blue Vitriol, soak.	7	7.3
50% Copper Carbonate, shoveled.	4	7.3
Formaldehyde, sprinkle and shovel	24	9.4
*20% copper carbonate, commercial machines.	8	12.5
Formaldehyde, dip.	1	15.0
NO TREATMENT	9	24.8
TOTAL	110	5.9

*These eight fields include the one that showed the most smut in the entire survey - 54 per cent.

Does Seed Treatment Pay?

The answer to this question is readily found by examining Tables 65 and 67, where it is seen that treated fields showed 5.9 per cent smut in comparison with 24.8 per cent in the untreated. An increase in yield of nearly 19 per cent at a cost of about 10 cents per acre is certainly worth while.

Some excellent examples of the benefits of seed treatment were noted. In Gallatin County, Montana, F. C. Meier and H. E. Morris saw a 180-acre field of Turkey wheat the seed for which had been treated with 50% copper carbonate by means of a good commercial machine. It showed an average of 0.7 per cent smut. The same seed, untreated, and sown in a strip across the middle of the field and in two corners showed 13.4 per cent. They also found a field of untreated Turkey wheat that averaged 50.7 per cent smut. On inquiry they learned that wheat comparable to this had also been sown by three other growers each of whom had treated it before planting. An examination of these farms showed the following:

Grower A.	Seed untreated	50.7 per cent smut
Grower B.	50% copper carbonate with machine	4.7 per cent smut
Grower C.	50% copper carbonate with machine	7.1 per cent smut
Grower D.	Blue vitriol. Soaked in sack 5-10 minutes	13.7 per cent smut

In Fergus County Mr. Kidder observed an 80-acre field of Turkey wheat of which 70 acres had been sown with formaldehyde-machine-treated seed and 10 acres with untreated seed that had been dipped in water. It was all the same seed and sown at the same time. The treated portion showed 2.5 per cent smut, the untreated 33.4 per cent.

Effect of Previous Crop - Soil Infestation

Evidences of soil infestation were observed in Montana. The mere fact that it was so difficult to get control by seed treatment points that way. Also the much greater severity on winter than on spring wheat is an indication. Furthermore, studies of conditions on individual farms suggested soil contamination. Mr. Meier found a field where the infection was much heavier in the area in the lee of last year's straw stack.

Most of the fields were sown on land that had been summer fallowed in 1929 and only 12 instances were recorded of wheat following wheat. It may be of interest to note, however, that in these 12 fields the average percentage of smut was 11.8 per cent, while 75 fields definitely recorded as being fallowed in 1929 had an average of only 7.6 per cent smut.

Varieties

Almost all of the winter wheat was of the Turkey variety, although 22 fields of Karmont, 2 fields each of Crail and Montana 36 and one field of Kharkof were recorded.

CONCLUSIONS

The prevalence of smut in the spring wheat area may be accounted for by (1) An insufficient number of farmers treating, and (2) Failure to get results on the part of some of those who do treat. The principal reason for failure seems to be not low grade chemicals, not the weather, and not soil infestation, although the latter may play some part in Montana winter wheat, but rather lack of attention to the details of the standard, recommended methods.

Importance of smut-balls. The most important detail that is neglected, in the opinion of the summarizers, is that of removing smut-balls. It has always been the recommendation of the U. S. Department of Agriculture that smut-balls should be removed by thorough fanning or otherwise; that if liquid treatments such as formaldehyde or copper sulphate are used the seed should be soaked, loose in open vats or tubs, and the smut-balls that rise to the top skimmed off, or else treating machines that remove smut-balls be employed. The sprinkle and shovel method of applying formaldehyde as for oats, never has been advocated for wheat, except possibly in cases where the seed was definitely known to be free from smut-balls, and yet it is surprising to note that nearly two-thirds of those treating with formaldehyde are using that method. This treatment does not remove smut-balls. The dip treatments that were applied for the most part did not take out smut-balls as in most instances the grain was dipped in sacks and then spread out or set aside to dry. The machines of the automatic sprinkle and auger types are unsatisfactory for the same reason. Elevator machines that were in good working condition seemed to be the only ones that fulfilled the requirements.

Several investigations have shown that spores in the interior of unbroken smut-balls are not affected by liquid or dust treatments, and that in the process of handling and drilling the smut-balls may be broken and reinfect formaldehyde-treated seed. Regarding this fact Humphrey (1) writes,

> "Another series of laboratory experiments designed to test the efficacy of various strengths of bluestone, formaldehyde, and other fungicides in killing the spores of unbroken smut-balls has revealed the fact that even though these unbroken smut-balls are soaked until they sink to the bottom of the solution, the contained spores when properly planted in culture dishes will invariably germinate. The membrane which encloses the mass of spores in the smut ball is a very excellent protective device against the entrance of water and it is almost a certainty that hundreds or even thousands of these smut balls pass through the ordinary methods of treatment unbroken, and hence unaffected by the fungicide, later to be crushed by the movement of wheat in the drill at time of seeding. This doubtless accounts in part for the occurrence of smut in fields planted to thoroughly treated seed."

In the case of the dusts there is a rather permanent coating of disinfectant on the outside of the healthy, treated seed that probably tends to partially prevent recontamination even if smut-balls are broken during drilling and viable spores scattered on the seed. This may explain the superiority of the copper carbonate treatment in many cases.

Data on the kind of work done by farm fanning mills and seed-cleaners were not collected but there many indications that many of them do not do a thorough

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Humphrey, H. B. The preventing of the stinking smut of wheat. Washington State Agr. Exp. Sta. Popular Bul. 48:1-4. 1912.

job of cleaning and practically no consideration is given to the removal of smut-balls. It is probable that a special survey of the quality of work done by farm seed-cleaning machinery at the time of seed cleaning and treating would show some interesting results.

Dust Treatments Cannot Be Made by Hand Shoveling. How so many farmers (37) got the idea that they could apply copper carbonate by the sprinkle and shovel method is a question. Very little or no control was obtained nor could it be expected by this method. At least two cases of sickness were reported because the operators inhaled the dust. The dust treatments should always be made in tight commercial or home-made treaters.

Dust or Liquid? The methods that gave the most complete control of smut as shown by the survey were--copper carbonate, both 20 and 50 per cent, formaldehyde and Ceresan all applied by machine. Any of these treatments when properly done have been shown to be effective both experimentally and practically. Of the treatments the balance would appear to be in favor of the copper carbonate. It is known that formaldehyde impairs germination in many cases whereas the dusts do not. As far as the expense is concerned there is not a great deal of difference between copper carbonate and formaldehyde. Formaldehyde is cheaper but both are inexpensive enough. Forty cents worth of formaldehyde will treat 50 bushels of seed, whereas 40 cents worth of copper carbonate will treat eight bushels.

On the other hand, in areas, such as the Dakotas, where the formaldehyde treatment is well known, where it is firmly established, where farmers are getting good results without much seed injury, it is questionable if it would be wise to try to supplant it with copper carbonate immediately.

Recommendations

The following recommendations, all of which have been made many times in the past, may be emphasized again on the basis of the facts collected on this survey.

1. Do not use smutty wheat for seed, unless absolutely necessary.
2. Clean and fan seed very thoroughly before treating with either liquids or dusts. It is very important to remove smut-balls because if left with the seed they may break and reinfect the treated seed. Cleaning and recleaning with efficient apparatus will remove them.
3. Copper carbonate dusts, either the 50 per cent or the 20 per cent, applied with good commercial or home-made machines, seem to be the most satisfactory of any of the treatments.
4. Formaldehyde applied with machines that remove smut-balls seems to be a satisfactory treatment. The matter of seed injury must be taken into consideration, however.
5. Ceresan appears to be slightly less effective than the above in reducing smut but nevertheless gave fairly satisfactory control. It does not reduce germination. It is more expensive than copper carbonate.
6. The formaldehyde treatment should be made using a machine that allows the smut-balls that may remain with the seed, to rise to the top and be skimmed off; or by soaking loose in open tubs or vats, stirring, and skimming off smut-balls.
7. The formaldehyde treatment should not be made by the sprinkling and shoveling method nor by dipping in sacks if smut-balls are not all removed in cleaning.

8. The dust treatments tend to prevent recontamination of seed after treatment and have an advantage over formaldehyde for that reason. They should be made using good rotating, commercial or home-made machines.

9. On no account should dust treatments be applied by the shoveling method.

10. It pays to treat seed every year.

SUMMARY

An examination of 814 wheat fields comprizing 66,729 acres in 17 counties of Minnesota, the Dakotas and Montana in 1930, has shown that:

Sixty-two per cent of the spring and 92 per cent of the winter wheat growers treated their seed.

The average percentage of smut was: Spring wheat treated 2, untreated 4, total 2.8. Winter wheat, treated 5.9, untreated 24.8, total (110 fields in Montana) 7.4.

Formaldehyde was used on 74 per cent of the spring and 25 per cent of the winter wheat; copper carbonate on 20 per cent of the spring and 55 per cent of the winter wheat.

The percentages of smut in spring wheat following different treatments were: 50% copper carbonate with machine 0.3 smut; 20% commercial copper carbonate, machine 0.5; formaldehyde, machine 0.9; 20% copper carbonate, home-made machine, 1.1; Ceresan, machine 1.3; Ceresan, shoveled 1.3; formaldehyde, dip 2.0; formaldehyde, sprinkle 2.1; 50% copper carbonate, shoveled 3.2; 20% copper carbonate, shoveled 4.6. With winter wheat the results were about the same. Those who treated every year had 1.4 per cent smut. Those that did not had 4.7 per cent. The leading spring wheats showed the following percentages of smut in untreated fields, Ceres 9, durum 7, Marquis 4, Ruby 2.2, Marquillo trace, all hard red spring wheats 2.7, all durums 2.9.

THE MINNESOTA WHEAT SMUT SURVEY

by R. C. Rose

The counties selected for the survey in Minnesota were Redwood, Wilkin, and western Polk in different parts of the Minnesota wheat belt. It was decided that the survey should include approximately one hundred separate fields of wheat in each county. Individual field records were to be made out for each field visited. These records were to contain information on the amount of bunt present in the field and complete data on all factors that might influence the amount of smut. Part of the data on previous history of seed and details of method of treating, if any, were to be secured from the farmer himself.

The survey was started in Redwood County on the morning of July 10 by 3 men from the State College of Agriculture. This group was later joined by Mr. Sumner, of the N. W. Crop Improvement Association, and Dr. Haskell, of the U. S. Department of Agriculture, for short periods, so that there were 4 men in the field most of the time while the survey was made.

Although the number of fields inspected was over 300, the records of many were incomplete because in many cases the owner or operator was not at home at the time of the survey. An attempt was made to complete the records by correspondence through the mail. This resulted in completed records on 298 fields of wheat.

WHAT SEED TREATING METHODS ARE MOST COMMON

The completed records show that only 38 per cent of the fields inspected were from seed treated in 1930. This, no doubt, is partly due to the opinion held by many that it is not necessary to treat their seed grain every year. The formaldehyde method appears to be most common, for 63 per cent of those that treated, used this method, while only 28 per cent used the 20 per cent copper carbonate. Ceresan is not being used to any great extent in the 3 counties surveyed as only 4 per cent of those treating their seed wheat used this material. Two farmers used the hot water method, one used formaldehyde and copper sulphate, and one used the 50 per cent copper carbonate.

WHAT VARIETIES OF WHEAT ARE GROWN IN THE COUNTIES SURVEYED

Twelve different varieties of wheat were found in the fields inspected. The Marquis wheat was most common for 56 per cent of the fields were seeded with this variety while durum occurred in 15 per cent of the fields. Seed treatment was more common on the durum wheat than on any other variety. The survey records show that 67 per cent of the durum fields were treated while only 29 per cent of the Marquis fields were treated. The high discount on smutty durum no doubt has had some influence in raising the percentage of durum that is being treated, over other varieties. The discounts for smut in Marquis wheat have always been lower than that in durum and until recently it has been the practice in many places not to discount for smut in bread wheat. A unified system of smut discounts no doubt will have its effect in interesting more farmers in smut control methods.

WHAT COUNTIES TREAT MOST SEED WHEAT

The results of the survey show that 46 per cent of the fields inspected in Wilkin County were seeded with treated seed. Redwood County data showed that 41 per cent of the inspected fields were treated although very little durum is raised in this County. Records from past years show smaller percentages of smutty wheat coming from the northern part of the Red River Valley so it is not surprising that Polk County showed only 31 per cent of the fields were from treated seed.

HOW WERE THE SEED TREATING CHEMICALS APPLIED

Seventy-seven per cent of the farmers using formaldehyde applied it by the sprinkle method while 14 per cent applied it with commercial machines. Among the farmers using 20 per cent copper carbonate, 45 per cent applied it with barrel churns or cement mixers, 30 per cent applied it by shoveling over the grain and dust, 21 per cent used commercial machines for dusting while 3 per cent mixed the dust and grain in the drill box. Most of those using Ceresan applied it with a barrel churn. The method of applying the different chemicals is very important in checking results, as even the best of chemicals cannot give satisfactory results if used improperly. It is interesting to note that 30 per cent of the farmers who used 20 per cent copper carbonate mixed it with a shovel although this method of application has been discouraged by agricultural workers since copper carbonate was first introduced in the State. It is to be expected that unsatisfactory results will follow the mixing of dust chemicals with seed grain by the shovel method or stirring them together in the drill box.

WHAT SEED TREATING METHODS GAVE BEST RESULTS

From the data secured in the survey, the commercial machines seem to offer the most uniformly satisfactory method of applying formaldehyde. The average percentage of smut on all fields treated by commercial formaldehyde machines was 0.7 per cent and the range was from 0 to 3.9 per cent.

The sprinkle method seemed to be more erratic, for we find the percentage of smut heads after this method of treatment, varied from 0 to 48 per cent. The average amount of smut on all fields from seed sprinkled with formaldehyde was 3.9 per cent. Here again, in discussing seed treating methods with farmers, we found many who failed to follow directions given out by the College of Agriculture. We found quite a number who seeded the grain immediately after treating without allowing it to stand covered for the required length of time. This, of course, would reduce the effectiveness of the treatment. The spray method averaged 8.5 per cent smut. This method is not recommended for wheat but a few farmers seem to think that they can make it work. The dip method is not popular with many farmers because of the extra labor. Those who used it, however, averaged only 3.5 per cent smut.

With the exception of one field, the seed treated with 20 per cent copper carbonate by commercial machines gave good results. This one field showed 38.7 per cent smut but on further investigation there seems to be some doubt on whether the dust feed was working properly and using sufficient dust to cover the seed. Without this field we find the other fields averaged only .2 per cent, which compares quite favorably with the other methods. When the above-mentioned field was included with the others, the 20 per cent copper carbonate, machine-treated seed averaged 6.3 per cent in the following crop.

The barrel churn or cement mixer was the most common means of applying the 20 per cent copper carbonate dust. The fields from seed treated in this way showed only 1.5 per cent smut heads. This method seems to be quite successful in the hands of most farmers. The ten farmers who mixed the 20 per cent copper carbonate dust and seed wheat by the shovel method had a smutty crop varying from 1.1 per cent to 24.7 per cent. The average on these fields was 7.4 per cent. The method is unreliable and not worth the farmer's effort. Only one farmer included in the survey attempted to mix the dust and seed grain in the drill box. His field showed 8.2 per cent smut. This method is about as good as nothing and any one that tries to get results from it might just as well try a few magic words. Very little smut occurred on the fields treated with Ceresan, but this method is more expensive than the others, and therefore not apt to replace copper carbonate unless the price is lowered. The results on the five fields treated with Ceresan are promising as far as they go.

The average amount of smut on fields not treated in 1930 but treated in 1929 was 2.1 per cent. The fields from seed not treated in 1930, and with no record on previous treatments showed an average of 5.1 per cent smut. Where the seed had been grown for some years without treatment, the fields showed an average of 4.4.

In the durum wheat the amount of smut in the untreated fields was higher than in any of the other varieties. Durum wheat treated in 1929 but not in 1930 averaged 5.3 per cent smut. Durum not treated in 1930 and without record of previous treatment averaged 16.4 per cent smut. Durum wheat not treated in recent years showed an average of 18.4 per cent smut.

SUMMARY

Seed treatment properly applied is good insurance against losses from bunt or stinking smut of wheat.

Many cases of reduced efficiency of seed treatment can be traced to the failure to follow treating directions carefully.

Mixing dust chemicals and seed grain by shovel or in drill boxes is a poor excuse for seed treatment and the results are usually not satisfactory.

Seed treatment every year is a safe practice as smut may reappear in the crop a year after treatment.

Table 68. Materials used in treating seed on Minnesota farms covered by 1930 smut survey.

Materials Used	Fields Treated
Hot water	2
Formaldehyde + copper sulphate	1
Copper carbonate 50%	1
Ceresan	5
Copper carbonate 20%	33
Formaldehyde	74
Total	116

Table 69. Varieties of wheat covered by 1930 smut survey, Minnesota.

Varieties	Number of Fields	Total Acres	Fields from Treated Seed	Fields from Untreated Seed	Percent of Fields Treated	Percent of Fields not Treated
Garnet	1	60	1	0	100	0
Winter	1	40	1	0	100	0
Montana King	2	180	1	1	50	50
Velvet Chaff	2	126	1	1	50	50
Hope	3	24	2	1	66	33
Reward	4	90	2	2	50	50
Quality	6	62	0	6	0	100
Ruby	13	458	2	11	15	85
Marquillo	22	927	8	14	36	64
Ceres	29	1890	18	11	62	38
Durum	46	2519	31	15	67	33
Marquis	169	8051	49	120	29	71
Total	298	14427	116	182	39	61

Table 70. Corelation of the adoption of seed treatment with varieties grown and region surveyed

Counties	Marquis			Durum			Ceres		
	Total Fields	Treated Fields	Percent Treated	Total Fields	Treated Fields	Percent Treated	Total Fields	Treated Fields	Percent Treated
Redwood	75	31	41	2	2	100	2	2	100
Wilkin	34	9	26	24	17	71	21	13	62
Polk	60	9	15	20	12	60	6	3	50
Total	169	49	29	46	31	67	29	18	62

Counties	Other Varieties			All Varieties		
	Total Fields	Treated Fields	Percent Treated	Total Fields	Treated Fields	Percent Treated
Redwood	22	6	27	101	41	41
Wilkin	15	4	27	94	43	46
Polk	17	8	47	103	32	31
Total	54	18	33	298	116	39

Table 71. Seed treating methods used on Minnesota farms covered in 1930 smut survey

Varieties	Farms using formaldehyde				Farms using 20% copper carbonate				Farms using Ceresan		Other methods			Total
	Commercial machines	Sprinkle	Spray	Dip	Commercial machines	Barrel churn or cement mixer	Shovel	Stir in drill box	Barrel churn	Shovel	Hot water	50% copper carbonate	Formaldehyde and copper sulphate dip	
Durum	2	19	1	2	2	3	2	-	-	-	-	-	-	31
Marquis	6	22	2	1	2	6	6	1	1	1	-	-	1	49
Ceres	2	7	-	-	3	3	2	-	1	-	-	-	-	18
Other varieties	1	9	-	-	-	3	-	-	2	-	2	1	-	18
All varieties	11	57	3	3	7	15	10	1	4	1	2	1	1	116

Table 72. Average per cent of bunt found on the different varieties following the different methods of seed treatment in Minnesota.

Variety	Formaldehyde				20% copper carbonate				Ceresan		No treatment in 1930			Hot water	50% copper carbonate		Cop. Sul. + formaldehyde
	Commercial machines	Sprinkle	Spray	Dip	Commercial machine	Churn or mixer	Shovel	Mixed in drill box	Churn or mixer	Shovel	Treated in 1929	No information on past treatments	Not treated in recent years	Commercial machine	Churn or mixer		Sprinkle
Durum	3.9	5.2	5.7	0	.5	4.	1.5	-	-	-	5.3	16.4	18.4				
Marquis	0.	4.7	10.	3.5	18.4	1.8	11.5	8.2	3.6	tr.	1.5	5.0	3.2				
Ceres	0.	1.2	-	-	0.	.7	.9	-	-	-	3.7	6.9	-	-	-		-
Other Varieties	0.	1.2	-	-	-	0.	-	-	0.	-	2.5	.5	0	0	0		7.6
All varieties	.7	3.9	8.5	3.5	6.3	1.5	7.4	8.2	.9	tr.	2.1	5.1	4.4	0	0		7.6

BUNT IN NORTH DAKOTA SPRING WHEAT

By W. E. Brentzel

A smut survey was made in Cass, Steele, and Towner Counties for bunt. During the latter part of July, Dr. Haskell, U. S. Department of Agriculture, and Brentzel, North Dakota Experiment Station, worked in Cass and Steele Counties. Towner County was surveyed by Dr. Walker, Plant Disease Survey, in the early part of August.

In all, 75 wheat growers were visited and their fields, about 131 in number, were studied. Smut was found in abundance. An average of more than one out of every three fields examined were smutty in appreciable amounts. In general the percentage of smutted heads was not high in most of the fields, but if the average of smut found in these counties may be taken as a fair representation of the State, more than 2 percent of the wheat heads produced were smutted. If the yield in North Dakota this year was approximately 100 million bushels of common and durum wheat, the loss might be estimated at more than 2 million bushels, which if sold at 70 cents would have amounted to 1.4 million dollars. If one-third of the wheat sold graded smutty and the average dockage was 3 cents per bushel, another million dollars in dockage was lost. The total would be approximately 3-1/2 percent of the value of the wheat crop.

The survey showed that both common and durum wheat fields were frequently smutty, and that both species of smut, Tilletia laevis and T. tritici occurred in abundance. This was true, although 75 per cent of the growers had treated their seed with chemicals to prevent smut. Almost 90 per cent of the growers who treated, used formaldehyde as the disinfecting chemical. Approximately one-third of the treated fields which were examined were smutty, while two-thirds of the untreated fields were smutty.

The lack of better smut control from the treatment in general practice was due, it is believed, to several factors. Formaldehyde, when properly used, is very effective as a disinfectant for stinking smut. When not properly used it is no better than the method employed. About one-half of the farmers who treated seed, did not use a treating machine, but depended upon a sprinkling can and shovel as their only equipment for treating. The result was that 35 per cent of the fields treated without using machines were smutty, whereas only 15 per cent of those treated with machines were smutty.

The kinds of treating machines used varied from those which were made on the farm to the best types of power machines obtainable. The most common type in use was a small sprinkling machine, more or less automatic in operation; that is, the weight of the grain when shoveled into the hopper, operates a burr-like sprinkling apparatus which sprinkles the solution onto the seed as it escapes. This type of machine seemed to do very good work, is inexpensive and handy to use, but it does not remove smut-balls from the seed. Not many of the machines will remove smut-balls. If all growers had used good machines and had followed directions provided by the Experiment Station and the U. S. Department of Agriculture, it appears that smut would have amounted to practically nothing.

The fact that so much seed is not properly cleaned and graded to remove smut balls before treating probably was another very important factor. Also many growers forgot to cover the seed properly after treating, and thus failed to give the formaldehyde gas an opportunity to act on the smut.

It was observed that in each community the farmers generally followed the same methods of treating and handling seed wheat. It was also apparent that on the smaller farms, where less wheat was grown and a greater diversity of crops was produced, they were more careless about using precautions for smut control. In Towner County where the size of farms average close to 500 acres and wheat is the principal crop, each of the 35 farmers interviewed treated for smut, and more than 70 per cent of them used some type of treating machine. The result of this better practice reduced the amount of smut in Towner County this year to about 0.7 per cent as compared with 2.6 per cent in Cass and 3.4 per cent in Steele County, where the farms are smaller and where a greater diversity of crops are produced.

In all communities satisfactory smut control by means of proper cleaning and treating of the seed seemed to be possible.

SMUT SURVEY IN SOUTH DAKOTA

by E. A. Walker

From intimate contact with the farmers of the spring wheat section of South Dakota I am convinced that they are in sympathy with the work that was conducted the past summer on the smut survey project. The county agents need to be further encouraged along the course of advising the farmers to plant disease-free seed each year. The farmers appreciated the suggestions offered by the county agents and myself in regard to the possibility of having disease-free seed each year by resorting to better methods of seed treatment.

The large wheat farmers are better able to control the disease than are the smaller growers. They have the capital and usually the help to see that the treating operations are performed for the greatest control of the disease. The small farmers are more inclined to use the older and less effective methods of smut control. Only a few of the farmers in South Dakota have smut machines.

Formaldehyde appears to be the most common and most satisfactory material used for treating grain.

Copper carbonate is fast losing favor with South Dakota farmers because of its necessitating a treating machine for best success, and because it harms the drill when becoming exposed to moisture.

Ceresan used for treating wheat gave excellent results in controlling the disease wherever it was applied by the proper method.

The durum wheats show very high percentages of smut in comparison to other varieties. Red durum seems to be infected most severely. The variety Marvel is highly susceptible to smut even when treated properly.

In view of the fact there are many wheat growers in the counties visited in this survey who are disbelievers in the good of treating wheat for the prevention of smut, and some who believe that smut is not caused by an organism, it would be most encouraging for the county agents to get in closer touch with this group and educate and train them to the correct belief.

In South Dakota the old method of treating seed wheat is mostly in practice. The value and use of the smut machine, and newer treating materials are not known and appreciated by a large number of the farmers. There should be demonstrations and instructions to various small gatherings of these farmers whereby they will be able to understand more fully the added advantage of using newer materials and more efficient smut treating equipment.

Table 73. Summary of smut survey of the four counties in South Dakota.

Varieties	Spink Co. Percentage Smut	Brown Co. Percentage Smut	Day County Percentage Smut	Marshal Co. Percentage Smut	Average Percentage Smut
Marquis	0.3	1.9	0.8	--	1.0
Marvel	13.3	2.9	--	--	8.1
Ceres	0.9	4.2	0.9	5.9	2.5
Kota	0.0	0.0	--	0.3	0.1
Hope	1.8	--	0.1	--	0.6
Remfrew	0.0	--	--	--	0.0
Ruby	--	0.5	--	--	0.5
Succotash	--	--	0.0	--	0.0
Montana King	--	--	--	0.0	0.0
Red durum	1.1	1.6	1.2	1.6	1.4
Amber durum	0.0	0.4	0.5	0.5	0.4
Mindum durum	--	0.0	0.3	3.8	1.4
Acme durum	--	1.0	0.6	2.6	1.4
Mixed durum	--	2.3	0.5	2.5	1.8
D-1	--.	--	6.7	1.4	4.1
Nodak	--	--	3.1	--	3.1
D-5	--	--	0.3	--	0.3
Average	2.17	1.48	1.25	2.07	1.57

Table 74. Effects of various treating materials and methods on the percentage of smut in South Dakota.

Materials and methods	Percentage of smut				
	Spink County	Brown County	Day County	Marshall County	Average for State
Formaldehyde					
Sprinkle, shovel	0.45	0.99	1.16	0.43	0.76
Auger type	5.5	0.0	0.3	1.0	1.70
Barrel mixed	0.0	0.5	--	0.0	0.17
Automatic sprinkle	--	5.5	--	--	5.5
Pail-dip, drain	2.1	0.05	0.0	0.15	0.57
Hero-elevator type	--	0.0	0.0	5.77	1.92
Sack-dip, drain	--	0.0	0.0	--	0.0
Owen smut machine	--	--	0.0	--	0.0
Average	2.01	1.01	0.24	1.47	1.33
20% copper carbonate					
Dust, shovel	2.07	0.85	--	5.45	2.79
Barrel mixed	0.0	2.55	--	0.0	0.85
Dust, hoe	--	--	--	2.8	2.8
Smut machine	--	--	--	1.5	1.5
Average	1.03	1.70	--	2.44	1.98
50% copper carbonate					
Dust shovel	--	10.2	--	--	10.2
Barrel mixed	0.0	--	--	--	0.0
Average	0.0	10.2	--	--	5.1
Ceresan					
Dust, shovel	0.0	1.9	0.0	--	0.63
Barrel mixed	1.4	1.25	0.0	--	0.88
Average	0.7	1.57	0.0	--	0.75
Not known	--	--	9.3	--	9.3
No treatment	0.15	1.58	2.05	3.8	1.9
Averages	0.65	3.21	2.90	2.57	3.39

W I N T E R W H E A T G R O W E R S !

WILL YOU SPEND A DIME TO SAVE $3.50?

by
Waldo Kidder
Extension Agronomist, Montana State College

Much has been said about the need for the control of smut for wheat. The problem of smut control is always a serious one for smut not only reduces yields which increase the production cost per bushel but smutty wheat requires special handling which is expensive, so millers will not pay as much for it--in fact many mills refuse to buy smutty wheat at any price.

With a surplus of wheat to draw on it will possibly be even harder to sell smutty wheat than in the past and discounts for smut may be even greater. With

A FARM STUDY OF TREATING SEED WHEAT

Smut Treatment Material Used	Average per cent of smut found in fields
50% copper carbonate	2.5
20% copper carbonate	11.23
Formaldehyde	8.68
Bluestone	6.95
No treatment	26.21

low prices for good wheat staring us in the face it will stand us in good stead to control the smut losses if we are to stay in the wheat business.

Smut can be controlled even in winter wheat. It may take a few years of careful, systematic work on the part of the growers to absolutely eliminate it but it can be controlled to the point where smut losses are negligible.

We folks working with the colleges and experiment stations have been saying this for quite a few years. This year we wanted to find why Montana wheat growers were still standing a heavy loss. Accordingly, with the cooperation of the county agents, the U. S. Department of Agriculture and the Northwest Crop Improvement Association, a large number of grain fields were visited, the owner consulted about whether the seed grain was treated before planting to prevent smut, how it was treated, variety and a lot of other information relative to causes for smut. This work was carried on as a part of the smut prevention campaign started in Montana by the extension service this spring. The field survey of wheat fields was made in Fergus, Cascade, Judith Basin, Chouteau, Gallatin, Fallon, Wibaux, and Yellowstone Counties and it has showed some mighty interesting things from the farmers' own experience and it proves that smut can be controlled if proper seed treatment is given to seed before planting.

A summary of the results secured from the various methods of seed treatment and no treatment on winter wheat, in the area named, are shown in this article.

The results from this farm study on smut prove that failure to treat seed is too expensive for any farmer in this business of grain growing as the average

loss was over 26 per cent. This means not only a 26 per cent loss in yield but also a heavy smut dockage on the small part of the crop harvested. At the current prices of wheat--as low as they are--the loss per acre on average Montana winter wheat yields and with a 10-cent dockage will be over $3.50 per acre! And seed treatment with the best methods costs only less than 10 cents per acre! Surely there is no argument against the best possible treatment of winter wheat seed to prevent this loss.

The farm survey showed that the loss from smut can be largely prevented as the pure copper carbonate, that is, the 52% copper content carbonate, showed only 2-1/2 per cent loss. This is quite small and will undoubtedly show little or no smut dockage. The lighter grade copper carbonate did not show as good control nor did the formaldehyde treatment as the pure stuff, but a great deal better than no treatment.

We have not had time to work up the data to show the effect of different methods of applying the seed treatment nor of the effect of time of planting or dryness of soil on the amount of smut, but from a hurried checkup and from farm experience it would seem that it will be well to again call attention of winter wheat raisers not only to the pure copper carbonate but to mix it on the seed thoroughly in a good seed treater which will not only mix the seed and dust well, but at the same time be tight so that dust does not escape. Trying to mix the dust on the seed in the drill box or by shoveling over does not give good results.

From two to three ounces of the dust should be used on each bushel of seed. Before treating the seed should be thoroughly recleaned. A heaping tablespoonful of copper carbonate weighs approximately an ounce.

Late planted winter wheat and especially that planted in dry soil where germination is slow, favors smut, so treated seed should be planted as soon after September 10 as possible.

Following these practices, which have now been proved not only on the experiment stations, but also on the farms of Montana carefully and year after year, the grain growers can get rid of smut with its attendant loss in yield and value and higher production cost a bushel. If Montana grain growers are to keep in the business against the competition from other areas they must follow the best known methods, and smut control is one of them.

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Plate 1. W. Kidder, Extension Agronomist, Montana State College of Agriculture making counts of stinking smut and showing farmer how to recognize it. One yard of drill row is marked off and the number of smutty heads and healthy heads counted. Ten such counts are taken in each field and the average percentage determined.

Plate 2. Smutted heads of wheat. A. - Portion of drill row showing all heads smutty. The paper background was slipped in front of the healthy and in back of the diseased heads. This field showed 14% smut.

B. - Smutty and healthy heads in a yard row of durum. Left 12 smutty heads. Right 37 healthy heads. Picture illustrates relative height of diseased and healthy heads in the field. This field showed 14% smut.

Plate 3. Machines used for applying dust disinfectants to seed wheat found in use on farms in spring wheat area.

Plate 4. Types of formaldehyde machines found in use on farms during the course of the wheat smut survey in the spring wheat States.

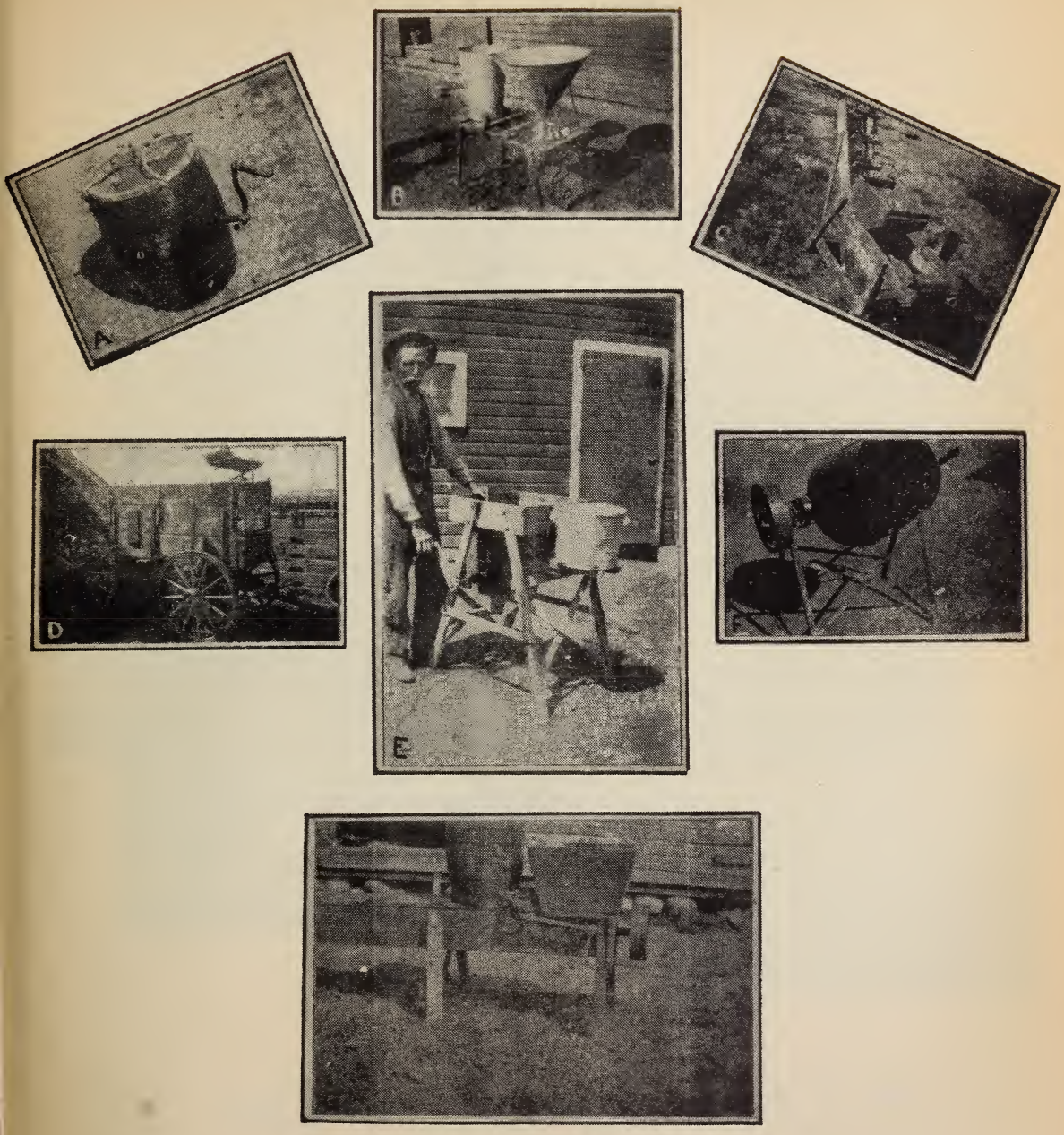
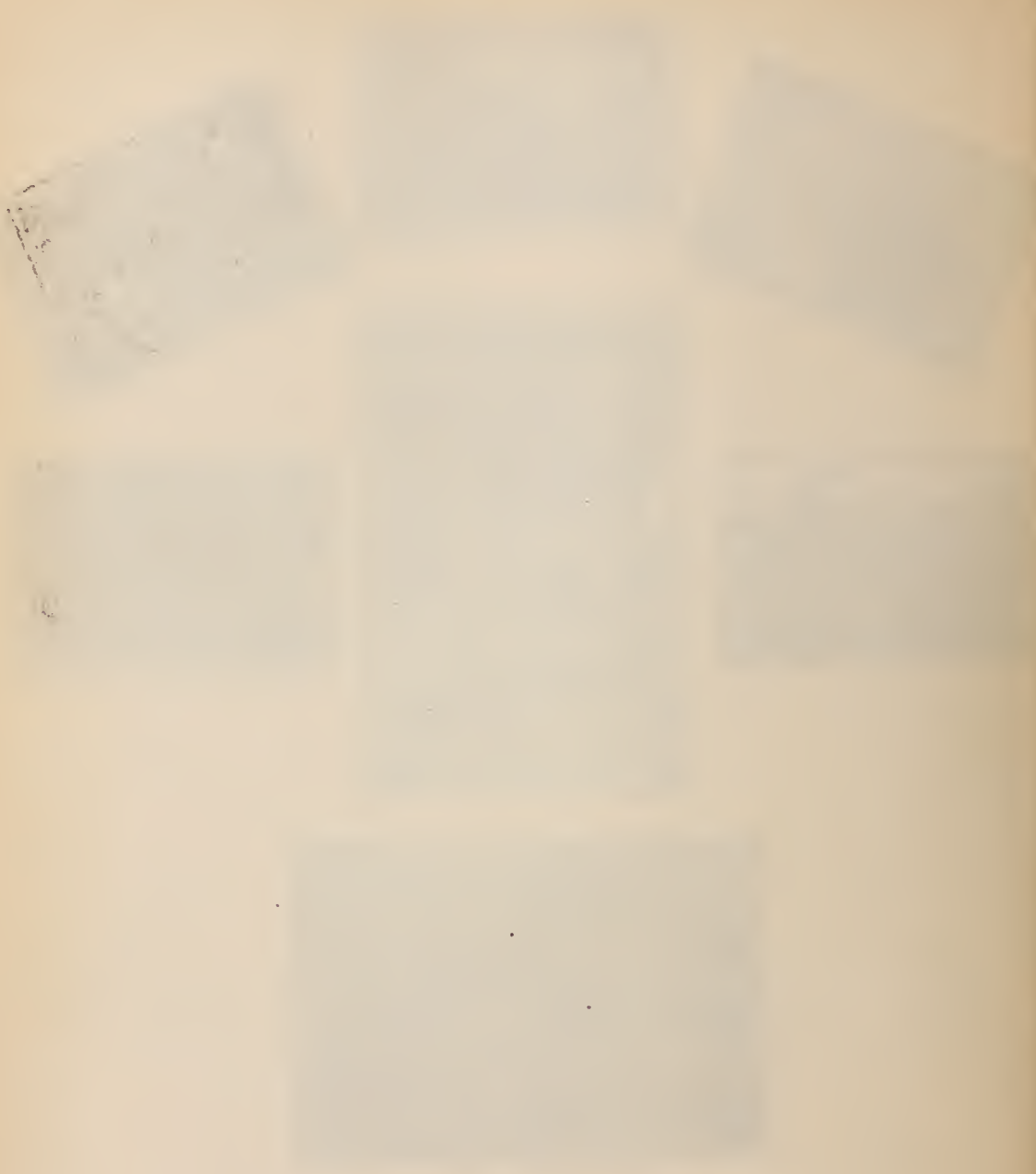


Plate 5. Some formaldehyde and dust machines on farms in the Dakotas.



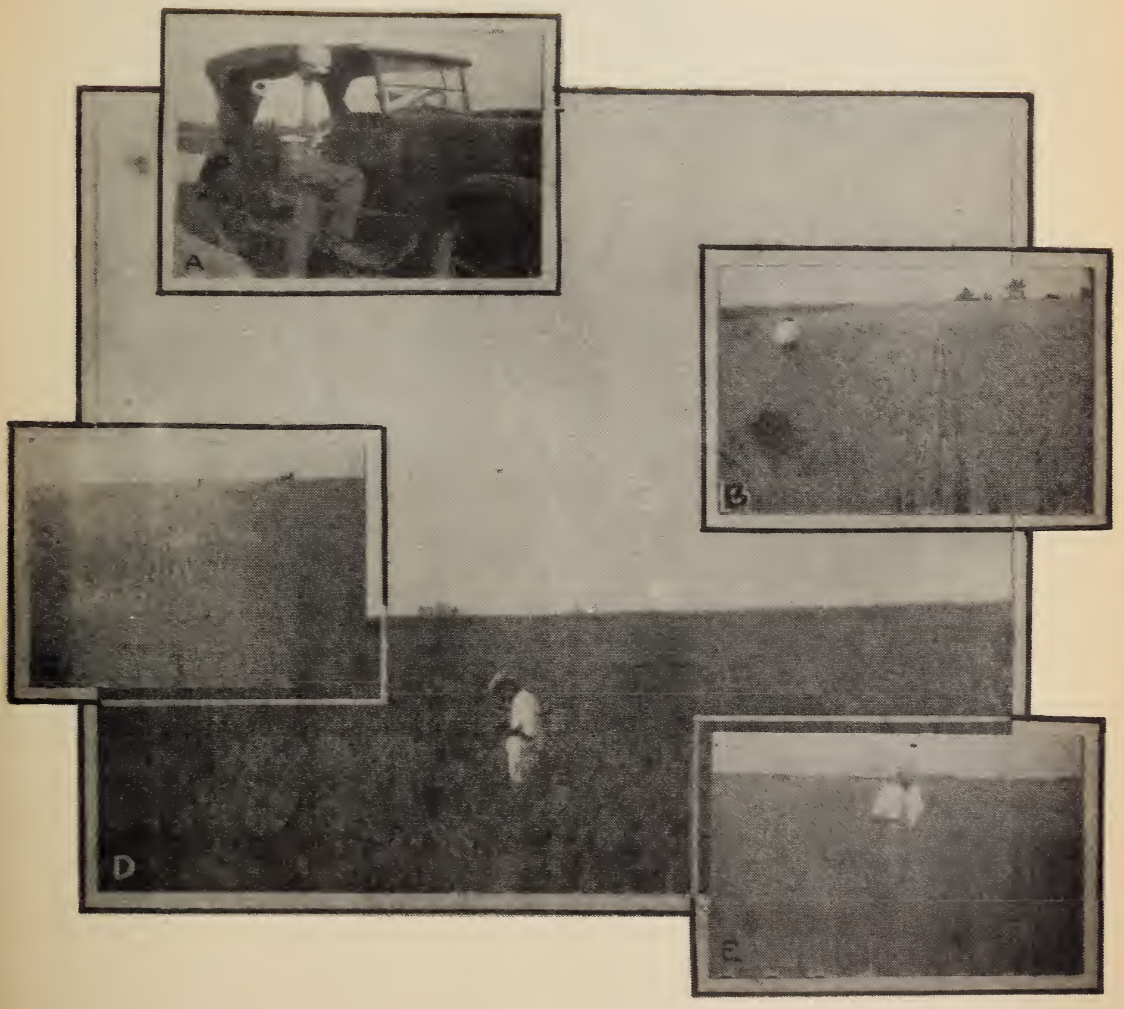


Plate 6. Surveying for stinking smut of wheat - 1930.

Plate 7.

A. This 20 acre field of durum was the smuttiest spring wheat found in the survey. It averaged 51.7 per cent smut.

B. The third smuttiest spring wheat field in the survey. The 84 acres of durum showed 42.7 per cent smut.

C. A field of Marquis which contained 18.7 per cent smut.